I. V. MICHURIN

SELECTED WORKS

И. В. Мичурин

IVAN VLADIMIROVICH

MICHURIN

SELECTED WORKS

FOREIGN LANGUAGES PUBLISHING HOUSE
MOSCOW
1949

Printed in the Union of Soviet Socialist Republics

PUBLISHER'S NOTE

The works of I. V. Michurin, both his complete works and various miscellanies, have been published in many editions in the Russian language.

Taking into account the enormous world-wide interest in the teaching of I. V. Michurin, especially in connection with the work of the session of the Lenin Academy of Agricultural Sciences of the U.S.S.R. held in July-August 1948, where Academician Lysenko's report "On the Situation in Biological Science," was discussed, the Foreign Languages Publishing House considers it timely to publish selected works of I. V. Michurin, so as to afford the foreign reader an opportunity to acquaint himself with them.

The present volume includes a part of Michurin's theoretical and methodological works, pomological descriptions of a number of varieties bred by him and a series ot articles reflecting the great public activity of this remarkable scientist.

For the convenience of the readers the articles are arranged according to theme; within the thematic sections they are given in chronological order.

CONTENTS

PROCESS OF BREEDING AND POMOLOGICAL DESCRIPTION OF MICHURIN VARIETIES

MISCELLANEOUS

INDEXES

PREFACE

The name of the famous Russian scientist in the field of biology, Ivan Vladimirovich Michurin, is known all over the world. He is known as a daring innovator in science, as an indefatigable researcher and as a great transformer of nature. He is particularly known and appreciated in the Land of the Soviets, the land of victorious Socialism, where there is every opportunity for the glorious growth of science, and where the creative and mighty talent of the great Russian scientist unfolded itself in all its power.

I. V. Michurin laid the foundation for a new materialistic biological science, the science dealing with the development and control of living nature. The general theory of the development of living nature and its directed alteration is the basis, the core of materialistic biology. Michurin's teaching contains within itself all of the basic elements of such a science: the principles and methods of research and the dialectical-materialistic views on the process of evolution in the plant and animal world. That is why Michurin's teaching is not of limited significance, but of general biological importance, and equally concerns all branches of biological science—horticulture, animal husbandry, medicine, physiology, ecology, and so on.

I. V. Michurin's theoretical principles are irrefutable, for they are correct inasmuch as they are founded not on mere reasoning or abstract deductions (as is the case with formal geneticists), but on numerous facts observed in life, in practice. The principles were established as a result of painstaking labour over many years, of a persistent struggle to master the laws of living nature. Step by step, with the conscientiousness of a genuine scientist and the perspicacity of a naturalist of genius Michurin penetrated the profound secrets of nature and disclosed them skilfully.

In his scientific-research work Michurin always kept in mind Engels' view that in dialectics "... nothing is final, absolute, sacred. It reveals the transitory character of everything and in everything; nothing can endure before it except the uninterrupted process of becoming and of passing away, of endless ascendancy from the lower to the higher." In citing this most important precept of Engels, I. V. Michurin states:

"This principle has always been and remains the basic principle of all my work. It has been emphasized in all of my numerous experiments on the improvement of existing varieties and on the origination of new varieties of fruit and berry plants."

Incidentally, many scientists who have no positive accomplishments to their credit either in theory or in practice "... have declared that plant organisms existing on the face of the earth do not change, that one cannot improve on nature, but I declare that all the diversity of plant forms has originated from a very limited number of plants as a result of an endless process of change taking place in nature, and I advance numerous facts to prove that man can and should improve on nature. ..." (I. V. Michurin.)

Michurin's teaching proceeds from the basic principle that new properties of plants and animals acquired under the influence of external conditions of life can be transmitted hereditarily. This means that qualitative change in the nature of plant and animal organisms depends on the conditions of life.

The main point in Michurin's teaching, therefore, is not crossing or hybridization, as is deliberately asserted incorrectly and falsely by the representatives of bourgeois formal genetics. *The main point, the basic principle in Michurin's teaching is the role played by environment, the purposeful and directed training of hybrids.*

Michurin regarded hybridization merely as the source of variability of properly selected parental forms necessary for obtaining new and desired properties in hybrids.

Michurin pointed out time and again that the work of a breeder does not end but only begins when hybrid seeds are obtained. The young organism resulting from the cross of the initial parental pairs is distinguished by its destabilized heredity and hence possesses great plasticity. By applying Michurin's diverse methods of training, it is possible to alter such an organism in the direction desired by the breeder.

Michurin pointed out that if an improper method of training is used, we may obtain a complete wilding from the best hybrid of cultivated varieties, and, contrariwise, by applying the required methods of training we may obtain a good new variety from a hybrid seedling possessing undesirable qualities. "*After all, it appears,*" Michurin stressed, "*that the hybrid's constitution depends only one-tenth on the parents and nine-tenths on the influence of the environment.*"

Darwin discovered the law of development of the organic world and established a proper conception of the evolution of living organisms. But he could not indicate *how to control evolution so as to create new forms of plants according to plan for the benefit of man. This task devolved upon Michurin.*

By developing the positive aspects of Darwin's teaching Michurin raised materialistic biology to a new, higher stage and thereby laid the foundation of Soviet creative Darwinism.

Already at the early stages of his work, Michurin completely refuted by numerous experiments the false theory of the well-known horticulturist Grell according to which old plants of southern varieties that had borne fruit many times could be acclimatized in more northerly regions.

Michurin proved by experiments that the acclimatization of plants is indeed possible, but "...only by planting the seeds. No foreign variety, if

not already able in its native environment to endure temperatures as low as the minimum temperature of its new home, can be acclimatized by transplanting complete specimens, cuttings, layers, and so on."

Michurin here for the first time propounded the theoretical principle that *the nature of a variety begins to be formed from the very first days of the seed's development, and that during this period it can be most easily changed in the desired direction by the conditions of training.*

Michurin's long and persistent efforts to find improved methods for extending the northernmost bounds of fruit cultures led him to apply hybridization of *geographically distant forms of plants with subsequent directed training of the hybrid seedlings.* And the farther away from their native place were the plants he took for hybridization, the more fully were combined in the hybrids the positive qualities of their parents, and the more readily did such hybrids adapt themselves to the severe conditions of the central zone of Russia, where I. V. Michurin lived and worked.

Michurin created the majority of his standard varieties precisely by the hybridization of geographically distant races and species of plants. Almost every variety bred by him serves as vivid proof of the correctness of his teaching that living beings, particularly young hybrid organisms, vary greatly under the influence of external conditions.

One of the greatest discoveries made by I. V. Michurin is the completely proved proposition that the variability of organisms arising both by sexual and asexual, vegetative means is governed by the same laws, and that there is no difference in principle between sex and somatic cells. Michurin proved this principle of major importance by his numerous experiments and researches on the vegetative hybridization of plants.

The sex cells, Michurin pointed out, in the final analysis are formed at a definite stage of the development of the organism from the very same somatic cells which go to build up its entire body. Hence, there is the closest interaction between vegetative and sex cells.

By means of vegetative hybridization, Michurin created fruit varieties of excellent quality. Along with his other varieties, bred by means of sexual hybridization, they are now propagated as standard plants in the majority of districts and regions of the Soviet Union.

Vegetative hybrids provide indisputable material for the proper understanding of that highly important property of organisms—their heredity. By controlling environmental conditions it is possible to change varieties in the desired direction, to perfect and to create new varieties possessing the heredity which we need.

I. V. Michurin elaborated the doctrine of development on the basis of the interrelations between the organism's historical past and its heredity. *He considered the organism in indissoluble connection with environment, in unity with it. Michurin considered as decisive the role of the external conditions in the formation of the organism.* "It appears," Michurin wrote, "that some people who imagine themselves to be experts in the laws operating in the plant world, naively question my assertion about the influence of

environment on the process of formation of new forms and species, alleging that it has not been yet scientifically proved.

"...First of all it is interesting to know whether they really believe that all of the 300,000 different kinds of plant species originated solely by means of hereditary transmission of parental characters (without any influence whatever on the part of environment).... Why, such a conclusion would be an utter absurdity. Indeed, it cannot be supposed that the entire vegetable kingdom existing on the globe at the present time originated from the first individual living plant organisms by means of cross fertilization in the course of tens of millions of years, without the influence of the environment the conditions of which so often and so greatly changed in the course of the centuries and millenniums that have passed."

By not limiting itself to deepening and developing Darwinism Michurin's teaching has played and continues to play an enormous role in exposing the antiscientific character of the various reactionary idealistic theories of the opponents of materialistic biology.

For many years the idealistic reactionary trend of Weismannism (Mendelism-Morganism) held sway in biological science.

The struggle against this antiscientific trend was waged by the only correct one—the materialistic trend of Michurin.

A sharply intensified struggle which divided the biologists into two irreconcilable camps, took place around the old and fundamental issue: *can plant and animal organisms inherit characters and properties which they acquire during their life*? In other words, *does the qualitative alteration of the nature of a plant or animal organism depend on the various conditions of life, i. e., on environment that influences it*?

The Michurin materialistic-dialectical trend in biology cites numerous facts in affirmation of such dependence. The Weismann (Mendel-Morgan) idealistic-metaphysical trend baldly denies such dependence, without adducing any proof thereof.

In August 1948 a session of the Lenin Academy of Agricultural Sciences of the U.S.S.R. devoted to a discussion of the situation in biological science was held in Moscow. At this session the Weismann (Mendel-Morgan) trend in biology was completely exposed and ideologically routed, as an antiscientific, reactionary, idealistic-metaphysical trend, divorced from life and sterile in practice, in contrast to the Michurin trend, which represents the creative development of Darwin's teaching, and is a new and higher stage in the development of materialistic biology. "The keynote of this discussion was Michurin's famous motto: 'We cannot wait for favours from Nature; we must wrest them from her.' This injunction of Michurin's, it may be said, is infused with the Bolshevik spirit, and is a call not only to scientific workers but also to the millions of practical farmers to engage in active creative work for the benefit and glory of our people." (V. M. Molotov.)

Michurin's teaching—the only progressive biological science in the world—has developed and become strong in the U.S.S.R., the land of victorious Socialism. That is no accident. "The Michurin teaching," Academician

T. D. Lysenko has said, "is inseparable from the practical collective-farm and state-farm activity. It is the best form of unity of theory and practice in agricultural science."

Michurin himself wrote that without the Soviet system he would have been "an unknown hermit of experimental horticulture in tsarist Russia."

Recalling pre-revolutionary times, Michurin wrote: "Before the Revolution my whole path was strewn with derision, neglect and oblivion.

"Before the Revolution I used to be insulted again and again by the judgments of ignoramuses, who declared all my work to be useless, to be mere 'fancies' and 'nonsense.' The officials from the Department of Agriculture shouted at me: 'You dare not do it!' The official scientists declared my hybrids to be 'illegitimate.' The clergy threatened me: 'Don't commit blasphemy! Don't turn God's garden into a brothel!' (that is how hybridization was characterized)."

I. V. Michurin, however, persistently strove to realize his aims. Being an ardent patriot of his country and an enthusiastic innovator, he devoted himself utterly to the service of his people. "I worked hard to fulfil the aim I had set," Michurin wrote later, "though I was without means, had no established standing, was completely isolated from society, and was engaged in a constant struggle against poverty and stagnation, making the best of the meagre resources which, along with painstaking and at that time absolutely unpaid scientific work, I was able to earn by my personal labour as a railway clerk and precision mechanic."

Knowing of Michurin's outstanding work and of his financial difficulties, the Department of Agriculture of the United States in the years 1911-13 repeatedly proposed that he emigrate to America, or that he at least sell the entire collection of his varieties, initial forms, and hybrids, on very favourable terms, of course. Michurin, however, each time declined the proposals. He considered that his accomplishments and collections should not serve to enrich capitalists, but should become the property of the people.

The first to direct attention to Michurin's work was V. I. Lenin. Despite the fact that the Civil War was raging and that the country's economy was in ruins, the Soviet Government in the very first months of its existence rendered Michurin the necessary aid. His nurseries at Kozlov (now called Michurinsk) were twice visited by the chairman of the Central Executive Committee, M. I. Kalinin.

Subsequently, in 1928 well-equipped laboratories were established in the Michurin nursery. This nursery was reorganized into a selection and genetics station, and later, in 1931, into the Michurin Central Genetics Laboratory.

For his outstanding services in creating new plant forms, the Soviet Government conferred on I. V. Michurin the Order of Lenin and the Order of the Red Banner of Labour. In 1932, the city of Kozlov, in which Michurin had lived and worked, was by a decision of the Presidium of the Central Executive Committee of the U.S.S.R. renamed Michurinsk.

Since that time the city of Michurinsk has become the largest scientific-research centre for the transformation of living nature, the largest centre for

disseminating Michurin's general biological ideas and the building up of progressive, Soviet agrobiological science. Bitterly recalling the gloomy period of his hard life and work under tsarism, I. V. Michurin remarked that "...Only under the Soviet system did I gain recognition in my own country. The first to take notice of my work was Vladimir Ilyich Lenin.

"Now that I am surrounded by the care and attention of the Party, led by Comrade Stalin, I have the opportunity to work even more productively in the great cause of renovating the earth."

On the eve of the 60th anniversary of his scientific activity I. V. Michurin sent a letter to Comrade Stalin, in which he summarized, as it were, the aid rendered him by the Party and the Government.

"The Soviet system," Michurin wrote in that letter, "has transformed the small undertaking which I started on a mean garden plot sixty years ago for breeding new fruit varieties and creating new plant organisms into a vast Union-wide centre of industrial fruit breeding and scientific plant breeding, with thousands of hectares of orchards, magnificent laboratories and facilities and dozens of highly skilled researchers.

"And myself, a lone experimenter unrecognized and ridiculed by the official savants and bureaucrats of the tsarist Department of Agriculture, the Soviet system and the Party which you lead have made the director and organizer of experiments with hundreds of thousands of plants.

"The Communist Party and the working class have given me everything I need—everything an experimenter can desire for his work."

I. V. Michurin was particularly deeply affected by the warm telegram of greetings received from Stalin on the 60th anniversary of his scientific activity. The telegram reads as follows:

"Most sincerely congratulate you, Ivan Vladimirovich, on the occasion of your sixtieth anniversary of productive labour for the good of our great motherland.

"Wish you health and new achievements in work of transforming fruit growing.

"I press your hand warmly.

J. STALIN."

Michurin's teaching has yielded excellent results.

Firstly, Michurin himself originated about 300 new varieties of fruit and berry plants. But that is not all. He pushed the notorious Humboldt zone far to the north. He made plants grow and bear fruit in regions where, not long before his day, man had never dreamed of seeing trees bending under the weight of juicy fruits. Grapes in Chelyabinsk, apricots in Siberia, pears in the Altai Mountains. Like the magician in the fairy tale Michurin scattered over the vast expanses of the Soviet Union green massifs of fruit orchards and decorated them with hitherto unseen varieties.

But this, too, is not all.

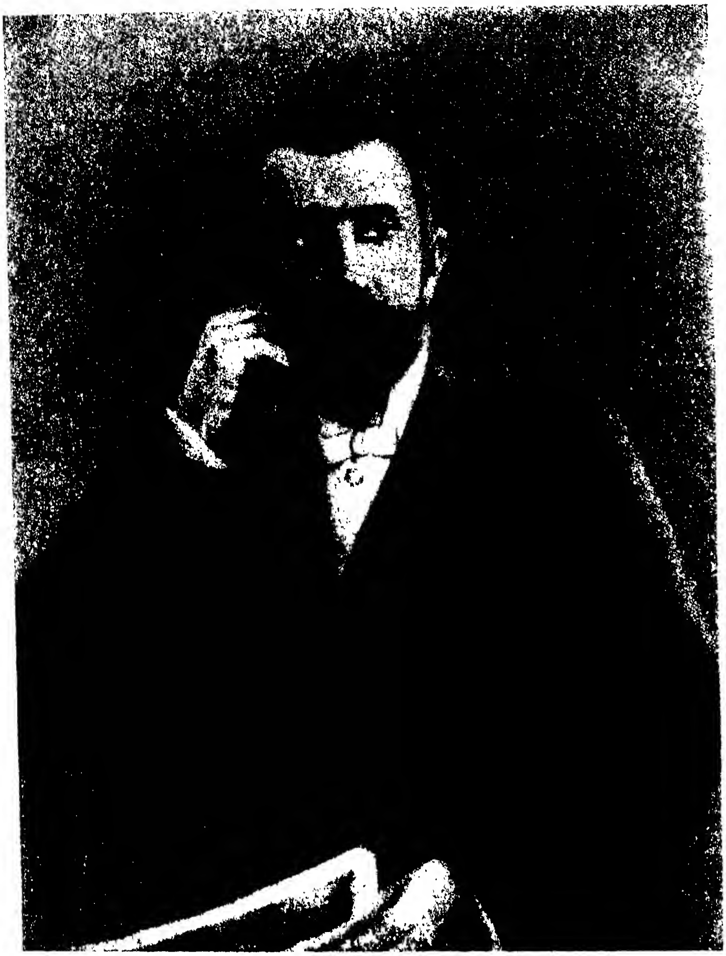
The huge million-strong army of his followers, the Michurinites, is the most precious capital created by the great transformer of nature. It is they

who are mastering the great heritage bequeathed to them by Michurin. It is they who are decorated with that brightly shining mark of honour—the star of Hero of Socialist Labour, of labour glorified and honoured on the socialist fields of the Soviet State.

The resolution of the session of the Lenin Academy of Agricultural Sciences of the U.S.S.R., which was held in August 1948, placed on record the great fruitful work of its president, Academician T. D. Lysenko, who headed the struggle to expose and to rout ideologically Mendelism-Morganism, and who took over the banner of Michurin materialistic biology. Academician Lysenko is successfully and fruitfully advancing Michurin's teaching. He is working on the most profound theoretical problems of modern biology. At the same time he is furnishing brilliant examples of the solution of practical tasks that arise in agriculture. Thus, having elaborated the theory of the phasal development of plants, T. D. Lysenko has, on the basis of this theory, worked out a valuable agrotechnical method known as vernalization which is now being applied in practice on millions of hectares of land. Among other agrotechnical methods which are the results of Lysenko's creative work are the sowing in stubble of winter crops in Siberia, summer planting of potatoes in the southern areas, cluster planting of kok-saghyz and forest belts, wide-row sowing of millet, topping of cotton plants, and so on

"...The future belongs to Michurin," Academician Lysenko stated in concluding his report at the session of the Lenin Academy of Agricultural Sciences of the U.S.S.R., "*V. I. Lenin* and *J. V. Stalin* discovered I. V. Michurin and made his teaching the possession of the Soviet people. By their great paternal attention to his work they saved for biology the remarkable Michurin teaching. The Party, the Government, and *J. V. Stalin* personally, have taken an unflagging interest in the further development of the Michurin teaching. There is no more honourable task for us Soviet biologists than creatively to develop Michurin's teaching and to follow in all our activities Michurin's style in the investigation of the nature of the development of living beings."

Academician *P. N. Yakovlev*



Ivan Vladimirovich Michurin, 1914

AUTOBIOGRAPHICAL DATA

BRIEF AUTOBIOGRAPHICAL NOTE

It will soon be forty years since I entirely devoted myself and all my work to horticulture, which I still love passionately. It may be that this was a heritage from my grandfather who put a great deal of personal labour into the cultivation of a big orchard on his family estate in Ryazan Province, or, perhaps, even a heritage from my great-grandfather, also a well-known horticulturist, who lived in Kaluga Province, where to this day there are several varieties of pears known as Michurin pears. Possibly the personal example of my father, who likewise devoted much effort to the cultivation of his orchard, also had a great influence on me from very early childhood. At any rate, as long as I can remember myself I was always completely engrossed in the work of cultivating plants. And my enthusiasm was so strong that I scarcely even noticed many other details in life; it is as if they all passed me by, hardly leaving any impression on my mind. Yet, thinking things over, what a vast amount of strength I spent, what a vast amount of arduous physical labour I performed and what a host of hardships I suffered because of the dire lack of means to achieve the aims set....

Now I myself can hardly comprehend how, with my weak and frail constitution and not trained from childhood for heavy manual labour, I could have endured all this. Only an all-absorbing passion, amounting to complete self-oblivion, could have instilled in me that incredible fortitude of constitution that makes one capable of performing work that is beyond his strength.

After completing my studies in a secondary school, the breakup and impoverishment of my family compelled me, against my desire, to abandon the idea of continuing my education in a higher school. I had to take a position with a private concern, in a railway office, where I received extremely small remuneration, hardly sufficient for living most modestly in the city. But despite all this, it was absolutely beyond my powers to give up my work with plants, for which I had such an affection. To continue this work I rented, at first, a small empty city lot which included a small neglected

orchard where I spent all my free time. The insignificant sums I managed to save from my salary at the office, often denying myself the barest necessities, were spent on the purchase of plants and seeds.

Soon the orchard lot I rented was so crowded with plants that I could not continue my work on it. Fortunately, I managed at the time to acquire a small plot of meadowland, about six versts from town, on a long-term purchase agreement, and I gradually removed all my plants there, carrying them on my own back. Then, when my gardening developed, I was able to give up my position and devote all my efforts to work in horticulture.

Already at the very beginning of my work in horticulture, I arrived at the conclusion, based on personal observations and partially on information gathered from well-known, experienced horticulturists during a tour of orchards in Central Russia specially undertaken for the purpose, that the quality of the varieties of fruit-bearing plants in all parts of Central Russia was very low. Consequently, I set myself the task of eliminating, by one method or another, so very grave a shortcoming in my favourite field. Unfortunately, I at first was enthusiastic about Grell's ideas of those days concerning the acclimatization of the best foreign varieties by grafting them on to hardy wildings. Much labour and time were lost on these erroneous experiments before I finally became convinced that the method was useless. Then, following the advice of Dr. Betling, I began to breed my own new local varieties of fruit-bearing plants from the seeds of superior-quality fruits. But it soon became clear to me that I could not expect to accomplish much without artificially crossing local varieties of plants with the best foreign varieties, because it is difficult to obtain higher qualities from mediocre varieties. To achieve this, the fruit of one of the parent plants must possess better, outstanding qualities. Consequently, it was necessary to resort to hybridization. For many years, step by step, I assiduously studied hybridization on the basis of comprehensive practical experiments, taking due account of the few theoretical findings which I had managed to gather at the time. I made tens of thousands of experiments. I grew a vast amount of new varieties of fruit-bearing plants from which several hundred new strains suitable for cultivation in our orchards were obtained, many being in no way inferior in quality to the best foreign varieties.

Further, I accumulated an extensive archive of rough notes pertaining to various observations on plant breeding and numerous photographs of plants. And all this was done on the small income derived from the sale of plants produced in a small commercial nursery specially established for the purpose. This income served to cover all expenditures, but practically nothing remained by way of savings.

Throughout the many years of labour devoted to improving varieties of fruit plants in Central Russia, I never received any subsidies or grants from the state, let alone thousand ruble salaries.

I worked the best I could on the means which I obtained by my own labour. Throughout the past period I constantly struggled against poverty and endured all kinds of hardship silently; I never asked for assistance from

the government so that I might more extensively develop this work, so highly useful and so very necessary to Russian agriculture.

On the advice of eminent horticulturists, I submitted several memoranda to our department of agriculture in which I tried to explain the vast importance and the necessity of improving and increasing native varieties of fruit-bearing plants by raising local varieties from seeds. Nothing came of these memoranda. *And now, at last, it is too late—the years have gone by* and my strength is exhausted. For my part I have done what I could; it is time to rest and to take care of myself, especially since I constantly feel the effects of failing health and diminishing strength.

It is very painful, of course, to have laboured so many years for the common good with no recompense and then to be deprived of security in old age. The consequences are that I shall have to go on with my arduous work to the end—an unenviable prospect....

And that, too, gentlemen, is the reason why I was compelled to close the nursery to visitors. I simply have no time to entertain sundry inspectors, gardening instructors, forestry experts and others who make almost daily visits to the nursery. I have absolutely no free time; I have no hired gardeners, I spend the whole day in the nursery and the better part of the night answering letters. The number of these letters from all parts of Russia, and lately from abroad, has, by the way, reached such proportions that my replies to the inquiries of orchardmen are sometimes delayed for several months.

First published in 1914 in
Sadovod, No. 6

THE HISTORY OF THE ESTABLISHMENT AND DEVELOPMENT OF THE NURSERY

At the first possible opportunity, as far back as 1875, when I entered the service of the Ryazan-Ural Railway, I began to spend all my free time and all the money left over from my salary on gardening.

After thirteen years (from 1875) of comprehensive theoretical and practical study of plant life, and especially of practical horticulture, of its needs in Central Russia, after a special tour of inspection of all the better-known orchards and nurseries of the time, and after personal tests of the qualities of fruit plants suitable for cultivation in the central and northern parts of European Russia, I arrived at the conclusion that our standard of horticulture was extremely low.

The assortment of plants was extremely poor and, in addition, it was corrupted by various semicultivated and sometimes altogether wild forest trees. At that time the most widely cultivated of the varieties of tolerable productivity were: apples—only Antonovka, Borovinka, Skrizhapel, Anis, Grushovka, etc.; pears—Bessemyanka, Tonkovetka, Limonka; sour cherries—Vladimirskaya and its seedlings; plums—various seedlings of damson and blackthorn.

Only rarely did one find in our apple orchards a sparse scattering of a few varieties of foreign origin (Reinette, Calville). There were no winter varieties of pears at all. As for sweet cherries, apricots, peaches and grapes, all these species of fruits were only rarely met with in hothouses and no one ever thought of cultivating them in the open ground. Under the conditions prevailing at the time, and with this kind of an assortment, there could be no hopes of orchards yielding anything like considerable profits. Yet the annual import of fruit from the South and from abroad cost the central and northern regions of the country many millions of rubles. It was clear that if we were to examine the established varieties of fruit plants in each region (Northern, Central European Russia, the Urals, Eastern and Western Siberia, the Caucasus and Central Asia) from the standpoint of profit yields and ruthlessly eliminate all varieties which proved unprofitable, then the list of remaining really profitable plants would prove a very small one indeed.

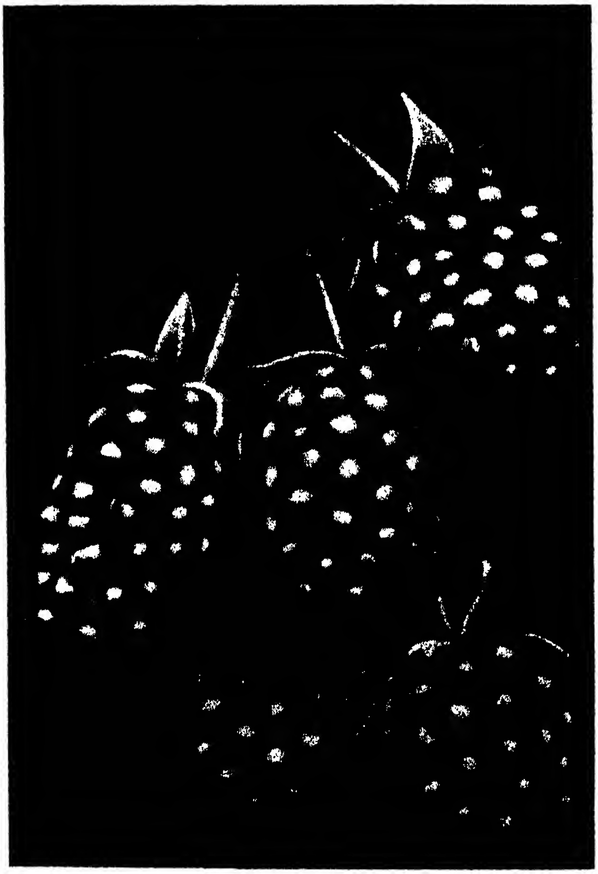


Fig. 1. New Texas raspberries

It became obvious that there was an imperative need to add new and better varieties. However, in doing so it was important not to repeat the mistake made by earlier horticulturists, who vainly hoped to acclimatize foreign varieties, but to produce from seeds our own new, improved hardy varieties for each separate locality. These were the ideas that prompted me to establish, in 1888, a nursery for the express purpose of producing new, better and more productive varieties of fruit-bearing plants. At first I endeavoured to achieve this goal by cultivating and selecting seedlings from the seeds of the best native and foreign varieties. But the results I obtained convinced me, in the end, that this method did not produce a sufficient degree of improvement in the new varieties. It turned out that the choice seedlings of the best

local varieties were only slightly superior in quality to the old varieties, while the majority of seedlings from the seeds of foreign varieties were not hardy enough and perished from frost.

I had to resort to hybridization, i.e., cross delicate foreign varieties selected for high productivity and good flavour with our local hardy strains. This enables the hybrid seedling to combine the qualities transmitted to it by heredity from the crossed parent plants—the beauty and improved taste of the foreign varieties with the endurance of our local frost-resistant plants.

Then, in the subsequent years, by practical experimentation the best methods for achieving the aims set were worked out. Along with this, definite techniques were acquired in applying a suitable regimen in training seedlings of new varieties (a detailed description of varieties will be found in the first volume of my works, published by the Novaya Derevnya Publishing House).[1]

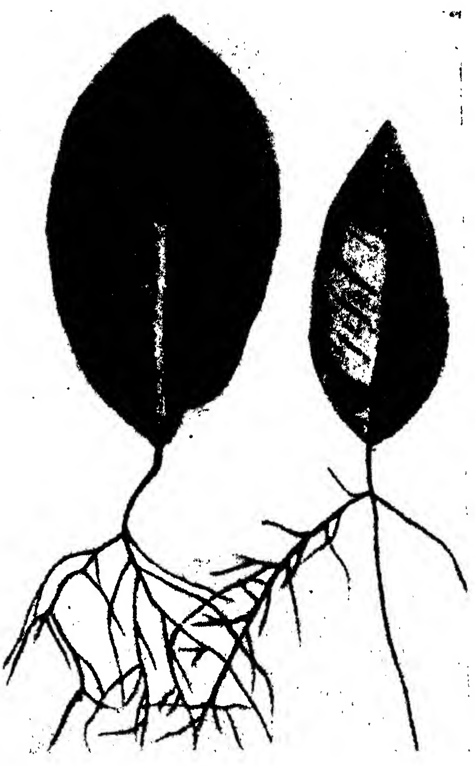


Fig. 2. Rooting of leaves

In 1900, when it was found that the new variety seedlings must be trained on lighter soil, I had to move the nursery to a new site six versts away, where the work continues to this day. Over two hundred new varieties have been produced, many of them in no way inferior to the best foreign strains. Their profit yields are from two to ten times as high as that of the old varieties.

In addition, a complete set of wild kindred plants necessary for hybridization has been acquired from foreign countries and from all parts of the Soviet Union. At present the nursery does not require any material from abroad; it has all the cultivated and wild species and varieties of plants it needs. This I consider to be one of the nursery's outstanding achievements, for now it has its own Reinettes, Calvilles, winter pears, sweet cherries, apricots, Reine Claudes, sweet chestnuts, walnuts, black gooseberries, Caucasian pshat, large-sized raspberries, blackberries, the best varieties of currants, early-ripening melons, attar roses, frost-resistant, early-ripening varieties

[1] I. V. Michurin, *Results of Half a Century of Work in Producing New Varieties of Fruit and Small-Fruit Plants*, Novaya Derevnya Publishing House, Moscow 1929.—*Ed.*

Fig. 3. Oleg Pantakl apple

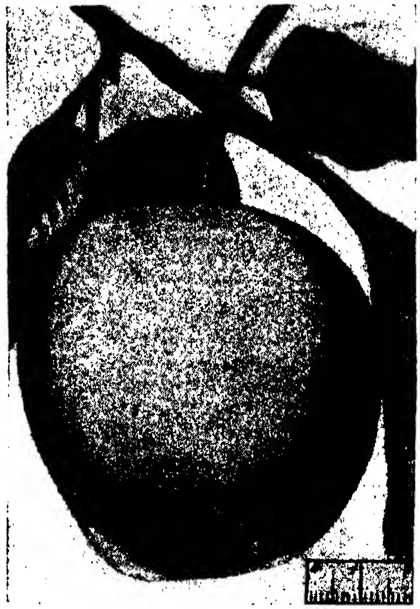


Fig. 4. Kandil-Kitaika apple—hybrid of *Pyrus prunifolia* × Kandil Sinap

of grapes [Figs. 1, 3, 4, 5, 6, 7, 8], yellow cigarette tobacco and many other new species of plants useful in agriculture.

Experiments have recently begun in methods of propagating fruit plants by cuttings, layers and, finally, by rooting the leaves alone [Fig. 2].

We are beginning to cultivate new species of plants, never before grown in our localities as, for instance, apricots, almonds, four kinds of Actinidia and red acacia. In addition, over two hundred specimens of the newest varieties of trained and selected hybrids of the species enumerated above are now being tested. Their number increases from year to year.

By order of the Government the foundation was laid in 1921 for a propagation division of the nursery. We started with a plot of two hectares formerly belong-

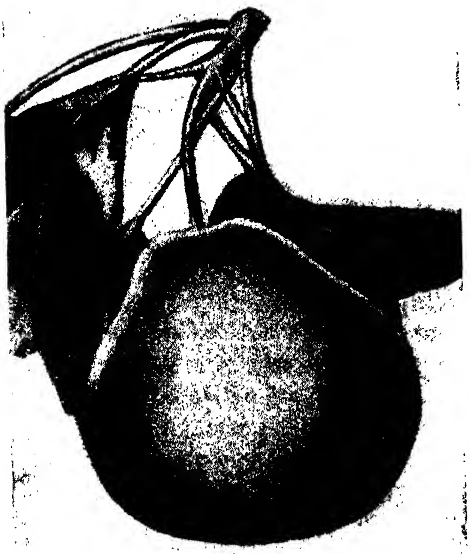


Fig. 5. Michurin Beurré Zimnaya pear

Fig. 6. Reine Claude Reforma

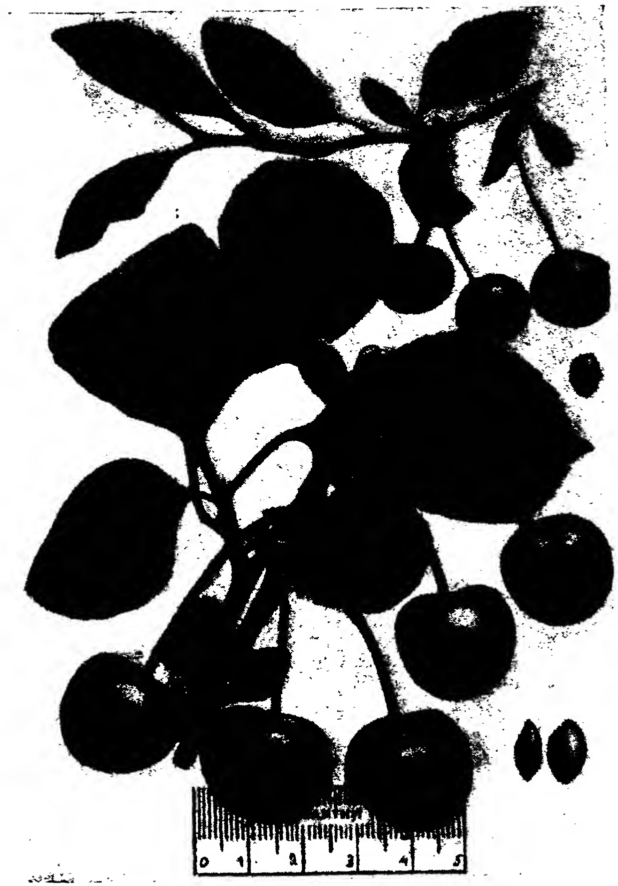


Fig. 7. Servirovochnaya sour cherry

ing to a monastery and in the course of seven years, thanks to the efforts of Comrade Gorshkov, the head of the division, it had gradually expanded to 158 hectares in 1929. This area is distributed as follows: 22 hectares—orchards, 26 hectares—nursery and seedling school, 44 hectares—truck garden, 11 hectares—farm crops, 3.3 hectares—experimental plot, 49 hectares—wooded park, 3.3 hectares—unused land, one hectare—buildings and 37 hectares—ploughland for a new nursery. The division includes a museum demonstrating the achievements of my work.

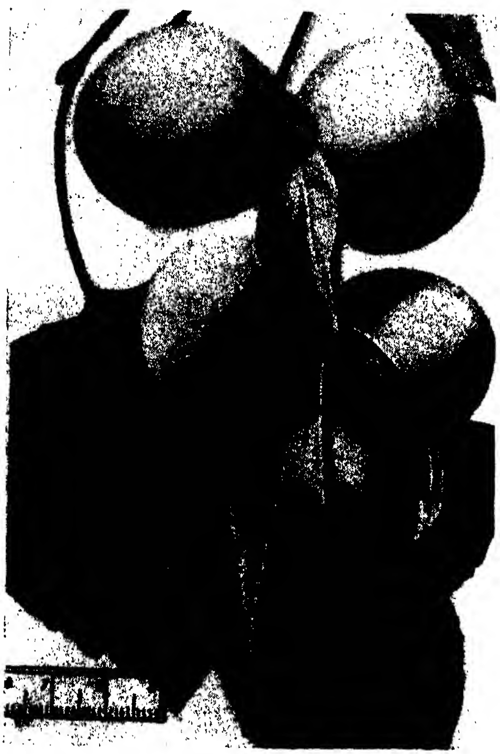


Fig. 8. Severny apricot

In 1928, the amount of grafted fruits and berries supplied to all parts of the Soviet Union was in excess of forty thousand. Two hundred thousand specimens were grafted in 1928 and yet it is absolutely impossible to meet the overwhelming demand for plants. Up to one hundred requests are received by mail in a single day. Hardly one-tenth of the orders received are filled. This is due, on the one hand, to the shortage of materials available for distribution, and also—and this is the main reason—to the fact that demands come from places with utterly unsuitable climatic conditions. Requests come in from the Transcaucasus, Northern Caucasus, the Crimea, the Transcaspian region, Kazakhstan, the Urals and Siberia, from our western border regions, from localities in the extreme north of the European provinces, etc. But the new varieties I have produced in Tambov Province can be grown to full advantage only in Tambov and neighbouring provinces under the climatic conditions to which they are accustomed. In the far South their qualities will not show up to the best advantage. In the North, on the other hand, they may suffer from harsh climatic conditions. Consequently, only a very limited number of orders from these areas can be filled, and only by way of experiment.

First published in 1929 in
Khozyaistvo TsChO,
No. 6

RESULTS OF MY SIXTY YEARS' WORK AND PROSPECTS FOR THE FUTURE

Now, when our great country has entered the period of Socialism, when Socialism has become tangible not only in the spheres of economics and culture, but also in science and technology, and when the time has come for the most extensive application of scientific knowledge in practical work, it is a pleasure for me, who has devoted some sixty years of effort to attaining a constant improvement of fruit and berry plants, and to producing absolutely new varieties of plants, to tell the working masses and the men of science about how I worked, what results I have attained and what the prospects are in the work of breeding new varieties of fruits and berries.

I am described as a spontaneous dialectician, an empiric, a deductivist. Without entering into a discussion about the correctness or incorrectness of these epithets, I consider it my duty to say the following in this brief review of my activities. I began my work in 1875, at the dawn of Russian capitalism when survivals of serfdom still existed. At that time not only was there no science of genetics (even now it is only in the formative stage)—a science which should be organically associated with plant breeding—but there was no such thing as scientific horticulture in general (a chair of horticulture was first founded in 1915), and all Russian science was regimented by Tsar Alexander. In short, I had no precedent in the organization of scientific breeding of new varieties of fruits and small fruits. Nor could I draw upon earlier, more or less serious experimentation, by others.

The one thing I saw was the unusual poverty of Central Russian horticulture in general and, in particular, the poor assortment of plants, as compared with other countries and our own South.

It pained me to observe the sad state of our horticulture, considering the exceptional importance of this branch of agriculture. I came to the conclusion, at the time, that horticulture in Central Russia, and particularly in Northern Russia, had not advanced a single step since time immemorial. . . .

What have we in the orchards of the vast areas of Central Russia?—I asked myself. Everywhere you saw only the traditional Antonovka, Anis, Borovinka, Terentyevka and similar antediluvian varieties of apples. There were still fewer pears, sour cherries and plums—only such old favourites as Bessemyanka and summer Tonkovetka pears, Vladimirskaya sour cherries and semicultivated sorts of damson and wild blackthorn.

Only rarely did one find orchards that could boast of a few varieties of Reinette apples of foreign origin, and in very insignificant quantities at that. The organisms of these plants had been exhausted long ago; they had become frail and sickly and had lost their resistance powers, with the result that the plants became an easy prey to disease and were plagued by pests for long periods.

The sorry picture of Russian horticulture in those days evoked in me a painfully acute desire to remake all this, to influence the nature of plants in a different way, and this desire was embodied in my own principle, now

universally known: "*We cannot wait for favours from Nature; we must wrest them from her.*"

I made this the basic principle of my work and am guided by it to this day.

However, having no precedents that I could follow in my scientific research, I was compelled, in the early stage of my work, to act by intuition and, somewhat later, to resort to the deductive method.

I set myself two bold tasks: to augment the assortment of fruits and berries in the central regions by adding high-yield varieties of superior quality, and to extend the area of southern crop cultivation far to the North.

But it was some time before I accomplished these tasks. I should point out that there are three sharply outlined stages in all my work.

THE ACCLIMATIZATION STAGE

In the eighties of the last century a pseudoscientific theory about the acclimatization of plants, propounded by the Moscow scientist Dr. Grell, was current. The substance of this "theory" was that in order to augment the assortment in the central regions it is necessary to take southern plants and gradually adapt them to our climatic conditions. And despite the fact that this method was fallacious, I chose it for lack of any other. The fact that the acclimatization of plants is, in essence, altogether unscientific was still unknown to me at that time.

In procuring plants from abroad—from the South—I expected that these foreigners would grow and bear fruit in our part of the country. But these experiments were not successful for the plants perished from frost in the very first winter. True, some specimens did bear fruit, but in the end they perished, too, or proved impractical for cultivation in our parts.

After this failure I employed another method; by means of grafting I attempted to bring the South to the North, believing that the southern varieties grafted on to our frost-hardy wildings would adapt themselves to our climate with greater rapidity, and that their seeds would produce seedlings from which, after being exposed to the influence of various factors, new improved varieties might be selected. But alas, here, too, I met with failure; all of my seedlings were killed by the frost during the first winter.

For ten long years, patiently suffering the grave consequences of fallacious methods, I got hundreds of adverse results but did not abandon my work and continued to try out one method after another.

THE MASS SELECTION STAGE

This stage is also the first stage in breeding new hardy varieties for each separate locality. This I tried to achieve by training and selecting seedlings from seeds of the best native and foreign varieties. However, it soon became evident that seedlings selected from the best local strains possessed only slightly higher qualities than the old varieties, while seedlings produced from seeds of foreign plants proved, in the majority of cases, too frail.

THE HYBRIDIZATION STAGE

In my subsequent work I chose pairs of parent plants from among the best local varieties and crossed them artificially, but again the hybrids thus derived fell short of the required standard. Next, I crossed our local plants with southern varieties, but while the varieties produced in this way yielded better-tasting fruits, in the majority of cases they could not keep through the winter. In my opinion, the properties of our local varieties of fruit-bearing plants in most cases dominated over the properties of southern plants, for our varieties originated in our localities and have grown there for hundreds of years, while the southern sorts are "newcomers" in our parts.

And so after that I struck an absolutely correct path, one at which science has arrived only in recent years—I began to cross races and species of plants of distant habitat.

Under this method the chosen pairs of parent plants were placed, in our part of the country, in an environment to which they were unaccustomed. The offspring of such crossbreeds were most adaptable to our climatic conditions and produced a more favourable combination of qualities, one that approximated the requirements I had set. As a result of such hybridization, the southern plants transmitted to their offspring flavour, size, colour, etc., while the wild frost-resistant species contributed their endurance to our severe winter frosts.

MY ACHIEVEMENTS

Following this, I proceeded to procure for my nursery plants from practically every part of the globe. By the October Revolution the nursery had approximately eight hundred species of initial plant forms. There were plants here from North and South Dakota, Canada, Japan, Manchuria, Korea, China, Tibet, India, Pamir, Indonesia, Central Asia, the Caucasus, Crimea, the Balkans, the Alps, France, England, the tundra regions, etc.

When in 1919 my nursery was placed under the supervision of the People's Commissariat of Agriculture of the R.S.F.S.R., it contained the following new varieties of fruits and small fruits, industrial crops and melons which I had produced:

apples	45	varieties	plums—Reine Claude and blackthorn (dessert)	15	varieties
sour cherries	13	„	apricots	9	„
sweet cherries	6	„	quince	2	„
almonds	2	„	currants	6	„
grapes	8	„	blackberries	4	„
raspberries	4	„	wild strawberries	1	„
gooseberries	1	„	ashberries	3	„
Actinidia	5	„	white acacia	1	„
mulberry	2	„	attar roses	1	„
tomatoes	1	„	melons	1	„
nuts	1	„	lilies	1	„
cigarette tobacco	1	„			
pears	20	„	Total	153	varieties

In my further work I managed to evolve a number of methods with the help of which I obtained outstanding varieties, frost-resistant not only in the Central Black-Earth Belt, but also in the Ivanovo Region and even further north, and in Siberia.

At the present time the assortment I have cultivated contains over three hundred varieties and represents a substantial basis for the socialist reconstruction of fruit and berry cultivation not only in the European, but also in the Asiatic part of the U.S.S.R. and in the high-altitude areas of the Caucasus (Daghestan, Armenia).

TWO WORLDS—TWO POSSIBILITIES

I have survived two tsars, and for over sixteen years now I have been working under a socialist system. I have entered another world, one diametrically opposed to the former. An abyss separates these two worlds.

That this is so may be seen from the following. Under tsarism, throughout my many years of work to improve the breed of fruiters, I received neither remuneration for my labours, nor, moreover, subsidies or grants from the tsarist exchequer.

I carried on my work the best I could on my own means, gained by my own labour. I struggled constantly against poverty and endured all manner of hardships in silence, never petitioning assistance from the government.

Several times, on the advice of eminent horticulturists, I submitted memoranda to the department of agriculture. In them I tried to explain the great importance and necessity of improving and replenishing our assortments of fruit plants, but nothing ever came of my memoranda.

I welcomed the October Revolution as historically necessary in its justice and inevitability, and I immediately appealed to all honest agricultural experts to come over to the side of the Soviet Government and unreservedly take the path of the working class and its Party. And to those who argued that "it is better to stick to the tried and tested, rather than strive for the new and the unknown" I replied, at the time, "You cannot cling to a part when the whole is rushing irresistibly forward." As early as 1918 I entered the service of the People's Commissariat of Agriculture and in 1919, with my fullest and sincerest consent, my nursery was declared state property.

Hardly had the Civil War come to an end when no other than Vladimir Ilyich Lenin, whose memory we all revere, gave his attention to my work. In 1922, on the instructions of Vladimir Ilyich, the work I was doing was expanded to unparalleled dimensions. Outstanding leaders of the Communist Party and the Government, headed by Mikhail Ivanovich Kalinin, Chairman of the Central Executive Committee of the U.S.S.R. and of the All-Russian Central Executive Committee, took an interest in my work. Mikhail Ivanovich paid two visits to my nursery.

I received three awards from the Soviet Government. At the All-Union Agricultural Exhibition in 1923, I was honoured with the highest

Michurinsk, Ivan Vladimirovich Michurin

Comrade Michurin, Ivan Vladimirovich.

Most sincerely congratulate you, Ivan Vladimirovich, on the occasion of your sixtieth anniversary of productive labour for the good of our great motherland.

Wish you health and new achievements in work of transforming fruit growing.

I press your hand warmly.

J. STALIN

Moscow, Central Committee C.P.S.U.(B.)
Joseph Vissarionovich Stalin

Dear Joseph Vissarionovich. Your telegram is the highest honour conferred on me in all my eighty years. It is dearer to me than all other awards. Your great attention makes me most happy.

Your *I. V. MICHURIN*

ПРИЕМ 22/9 21 ч. 25 м. пор. № 13
от ———— слов ———— пред. № ———
Принял Ковалева

УВЕДОМЛЕНИЕ ТЕЛЕГРАФОМ СЕР
Г МИЧУРИНСК МИЧУРИНУ
ИВАНУ ВЛАДИМИРОВИЧУ
1=1

174 СЕР Г. МОСКВЫ 0505 62/63 22 21 05=

=ТОВАРИЩУ МИЧУРИНУ ЗПТ ИВАНУ ВЛАДИМИРОВИЧУ ТОЧКА
АБЗАЦ ТОЧКА ОТ ДУШИ ПРИВЕТСТВУЮ ВАС ЗП ИВАН
ВЛАДИМИРОВИЧ ЗПТ В СВЯЗИ С ШЕСТИДЕСЯТИЛЕТИЕМ ВАШЕЙ
ПЛОДОТВОРНОЙ РАБОТЫ НА ПОЛЬЗУ НАШЕЙ ВЕЛИКОЙ РОДИНЫ
ТОЧКА АБЗАЦ ТОЧКА ЖЕЛАЮ ВАМ ЗДОРОВЬЯ И НОВЫХ УСПЕХОВ
В ДЕЛЕ ПРЕОБРАЗОВАНИЯ ПЛОДОВОДСТВА ТОЧКААБЗАЦ
ТОЧКА КРЕПКО ЖМУ РУКУ ТОЧКА АБЗАЦ
ТОЧКА И ТОЧКА СТАЛИН ТОЧКА

63 „Связьучет". 1031/1

МОСКВА ЦК ВКП(б) ИосифуВиссарионовичу СТАЛИНУ

Дорогой Иосиф Виссарионович телеграмма от Вашего имени явилась для меня высшей наградой за все 80 лет моей жизни Она дороже мне всяких иных наград Я счастлив Вашим великим вниманием Ваш И. В. Мичурин (МИЧУРИН)

МИЧУРИНСК Ц 23 9 34

J. V. Stalin's telegram and I. V. Michurin's reply

award—a certificate of the Central Executive Committee of the U.S.S.R. In 1925, on the occasion of the fiftieth anniversary of my work, the Government decorated me with the Order of the Red Banner of Labour, and in 1931, when horticulture was being reconstructed along socialist lines, I was awarded the Order of Lenin.

On the basis of my achievements the Government established a number of specialized institutions and schools catering to the entire Soviet Union and bearing my name: a scientific research institute of horticulture, a plant-breeding institute, a technical school, a workers' high school and an experimental centre for youngsters. The purpose of these institutions is to train agricultural experts with higher and secondary education. There is also a combined state farm and orchard of five thousand hectares that has been named for me, and, lastly, the city of Kozlov has been renamed Michurinsk.

Thus, by the will of the Party and the Government, the small nursery, confined to a tiny plot before the Revolution, has been transformed into an all-Union centre for research in fruit growing and plant breeding.

My feeling of solitude disappeared after the Revolution. I have a number of assistants who have done much to facilitate my work and have devoted a great deal of strength and effort to the organization and development of our all-Union research centre of fruit growing and plant breeding. They have earned my profound gratitude and respect.

HOW THE WORK I BEGAN SHOULD DEVELOP

The future prospects of my work have been outlined by the Government in its decisions of November 23, 1923 and May 13, 1931. These decisions point out that "the outstanding achievements of I. V. Michurin in the production of new high-yielding varieties of fruits and small fruits for the central regions of the U.S.S.R. are of enormous importance for the socialist reconstruction of horticulture and for heightening its technical level. The development of large-scale state and collective farms, the planned distribution of varieties and scientific cultivation methods create unprecedented opportunities for the extensive substitution of new, improved varieties for local low-yielding varieties."

The work which I have been doing for sixty years is inseparably bound up with the masses; it is their cause. But in order that the mass of the people might more quickly, and with the greatest possible benefit, take advantage of this work, the following measures must, in my opinion, be effected:

1. I think that the period of popularizing my work is over; it is no longer a matter of propaganda, but of making practical use of my achievements. Yet, the propagation and study of my varieties in various climatic zones is anything but satisfactory. Though I am in touch with thousands of kolkhozes and kolkhozniks, I feel no contact whatsoever with the regional and district agricultural administrations whose duty it is to disseminate my varieties.

There is a very large and ever increasing demand from kolkhozes for my varieties but, contrary to Government decisions, the local cultivation of stock is conducted on an insignificant scale.

It seems to me that the work of putting my achievements to practical use should be placed under the control of the political departments of machine and tractor stations and state farms.

2. The further development of breeding fruit and small-fruit plants requires regular expeditions to procure new specimens. In my research of the wild flora of the Far East I proved the importance of this aspect of the work and raised it to a scientific level.

3. Since our goal is not only to explain the world, but to change it so that it may better serve the needs of the working people, I regard plant breeding as a powerful instrument of our contemporary society, engaged, as it is, in the construction of Socialism. This instrument can help us master the nature of plants. That is why I think that instruction in plant breeding should be introduced in all agricultural schools, from primary schools to colleges.

First published in 1934 in
Transactions of the I. V. Michurin Plant-Breeding Station, Vol. II

LETTER TO COMRADE STALIN

Dear Joseph Vissarionovich!

The Soviet system has transformed the small undertaking which I started on a mean garden plot sixty years ago for breeding new fruit varieties and creating new plant organisms into a vast Union-wide centre of industrial fruit breeding and scientific plant breeding, with thousands of hectares of orchards, magnificent laboratories and facilities and dozens of highly skilled researchers.

And myself, a lone experimenter unrecognized and ridiculed by the official savants and bureaucrats of the tsarist Department of Agriculture, the Soviet system and the Party which you lead have made the director and organizer of experiments with hundreds of thousands of plants.

The Communist Party and the working class have given me everything I need—everything an experimenter can desire for his work. The dream of my whole life is coming true: the valuable new fruit-plant varieties which I have bred have gone from the experimental plots not into the possession of a few kulak money-bags, but into the far-flung orchards of the collective and state farms, displacing old inferior varieties of low yield. The Soviet Government has conferred upon me the highest reward a citizen of our country can receive, by naming the town of Kozlov the town of Michurinsk, awarding me the Order of Lenin, and publishing my works on an impressive scale.

For all this, as a token of my gratitude, devotion and love, all of my sixty years' work is dedicated to you, the beloved leader of the working masses who are building a new world, a world of joyous labour.

Dear Joseph Vissarionovich! I am eighty years of age, but the creative energy surging among the millions of workers and peasants of the Soviet Union fills me too, old man that I am, with eagerness to live and work under your leadership for the good of the socialist development of our proletarian state.

I. Michurin.

First published in 1934 in
Izvestia, September 20

PRINCIPLES AND METHODS

WHAT IS MEANT BY THE ACCLIMATIZATION OF FRUIT TREES

(REPLY TO MR. CHERABAYEV)

No doubt, one should not, in the ordinary way, take issue with Mr. Cherabayev's article in No. 10 of *Sadovodstvo i Ogorodnichestvo* [1905], as it is not based on personal experience, but on theoretical deductions made from the opinions of others; but in view of the adverse implications which this article may have for the development of horticulture in Russia, and of its total misinterpretation of the opinions expressed by myself on the subject of acclimatization, I am compelled, against my will, to take up the pen.

I must make the reservation that, both in my first article and in the present, I speak solely of the artificial acclimatization of fruit plants. Also, I should like to make clear to the reader the meaning and implications of the word acclimatization, at least as understood by myself, in its bearing upon the matter in hand.

In my opinion, a particular variety of fruit plant can be said to have been acclimatized only given the following. Firstly, if this variety, upon being transplanted from a place with a different climate, could not have grown in the new location on its own, but has reconciled itself to the new climatic conditions thanks to the rational, well-advised methods applied to it by the acclimatizer—and this without any change in the quality of its fruits. Secondly, if this artificially acclimatized variety has developed such permanent resistance that upon further propagation it will retain its acquired ability to grow and bear fruit effectively in the new locality, without requiring of man more care than local varieties do in order to keep alive.

If, on the other hand, the transplanted variety turns out to have been hardy in itself; or if, while being hardy in the initial single specimen, it loses this resistance upon further simple propagation; or if, lastly, its fruits show substantial deterioration—then, in my view, the term "acclimatization" ought not to be applied to it, because it would be pointless.

Accordingly, without knowing for certain that the conditions I have named did in fact obtain in the case of a particular transplanted variety, it is, to say the least, improper to claim that the variety has been acclimatized.[1]

To bring the point home more fully, let us take a few examples:

1) The Roditeleva cherry from Vladimir—a well-known and excellent variety—positively will not lend itself to acclimatization; transplanted to other areas, it grows well enough, but its yield is low, and the fruits deteriorate so much as regards flavour and size[2] that they lose all value and the variety becomes unrecognizable.

2) The Lyubskaya or Alfyorovskaya cherry is an excellent variety in its own locality, while in my orchard in the Tambov Province it bears such scanty fruit as to be totally unsuitable for us.

3) I have a fourteen-year-old specimen of a well-known and excellent variety, the Reinette d'Orléans, or, as fruit dealers call it, the [red] Shafran; it bears fruit every year—but what these fruits look and taste like! They are nothing but a wretched caricature of the Shafran. Our native Repka is infinitely superior. The same goes for the Beurré Slutskaya pear and other pear varieties. A host of such examples could be cited. How can it be claimed that these varieties have become acclimatized in our parts?

Acclimatization by the natural method of planting the seeds, on the other hand, offers an easier way of extending the assortment of plants in each locality and affords full opportunity of securing, by means of selection, varieties producing fruits of excellent quality and capable of withstanding a severe climate. Moreover, one can in this way acclimatize types of fruit trees which never grew in the locality before, as, for instance, the Kuzmin plum in Vetluga[3] or the cultivated apricot in my orchard in the Tambov Province.

That is why I said that the acclimatization of fruit trees was, with very few exceptions, possible only by planting the seeds; and I say so again, because out of the few varieties that have proved fit for our climate, the overwhelming majority owe the fact to their having already been capable in their native parts of withstanding a climate more rigorous than the one prevailing there, and not to having been introduced by the methods of Grell or other acclimatizers. They were simply transplanted,[4] not artificially acclimatized.

[1] As to the acclimatization of decorative plants, in which even considerable deviations do not matter greatly, I do not think I need go into a strict analysis of whether it is proper to use the term "acclimatization."

[2] You will say that this change is not due to the climate, but to the composition of the soil; however, in order to clear up this point, I had soil sent from Vladimir and tried it on one specimen, yet no improvement was to be observed.

[3] The town of Vetluga, in the Gorky Region.—*Ed.*

[4] It is in this way, and only in this way, Mr. Cherabayev, that the varieties you mention made their appearance in the Kiev, Kharkov and Kursk provinces. And not a whole deluge of varieties, as you put it, but only some dozen or score of them; all but two or three of which are already unsuitable for the Tambov Province, and even these two or three are second-rate as regards suitability to conditions there.

I too was at one time an admirer of the Grell method of acclimatization. It is a method for which many paid dear, myself included. A great deal of effort, money and time was practically thrown away. Acting on Grell's theory, I too miraculously acclimatized in the Tambov Province many of the finest foreign varieties of pears, and they grew and bore fruit well enough for several years, so that I not only myself came to believe in the possibility of miracles of this kind, but, eager to convince others, wrote an article about my experience in acclimatization, which appeared in the Russian Imperial Horticultural Society's *Vestnik Sadovodstva i Ogorodnichestva* for 1888, pp. 395-401.

But, as if to spite me, the very next winter half of these varieties were killed by frost, and in the succeeding years they were followed, with very few exceptions, by the rest. All in all, some three of these varieties managed to survive, and I comforted myself with the reflection that not absolutely all my work had been wasted. But afterwards I began to wonder whether perhaps these survivors were not hardy in themselves, even without my ingenious devices. To test this, I again ordered these same varieties from a foreign nursery, and my surmise was confirmed: these latest arrivals, grafted in the ordinary way in my nursery garden, proved as hardy as those I had acclimatized.

Sometimes one comes across varieties which are sickly when young, but afterwards, on reaching a more advanced age, grow and bear fruit well; when that happens, acclimatizers triumph, ascribing the tree's new-found hardiness to their own exertions and care, whereas actually it is simply an individual property of that variety.

It will happen, too, that a definitely delicate foreign variety chances to be grafted onto a wild stock possessed of an altogether exceptional power of overbearing the requirements of the scion, and its constitution undergoes changes in the direction of a more stunted habit of growth, more abundant crops, improved colouring of the fruits, or, lastly, of greater hardiness; and in the latter event, that is, if it achieves hardiness, acclimatizers attribute this success to their own efforts—and are, of course, mistaken, because when cuttings from such a hardy specimen are grafted upon other wildings, they again yield delicate plants. The proper procedure, of course, would be to propagate such an accidentally-discovered stock by layering, so as to retain and utilize its valuable property—dwarfed habit (as is done with the Paradise apple and the Doucin), and then to graft the delicate variety onto the layers.[1]

I must point out that such ideal stocks occur as individual variations in all botanical species of fruit trees, and certainly not as whole species, as for example, *Pyrus baccata*, which Grell introduced as a stock on the basis of a theoretical appraisal of its qualities, and which, incidentally, has so signally failed to live up to the hopes entertained of it that it would be well to give

[1] It may happen that other varieties will not be influenced by the same stock.

up using this kind of stock, at least in our locality, because *Pyrus prunifolia,* for example, is much better adapted to the requirements of horticulture in these parts.

Lastly—but here I am speaking of a conjecture, not a fact—there probably also occur, though extremely seldom, stocks with the power to induce permanent changes in the properties of certain varieties grafted upon them; and if this change is in respect of hardiness too, the resultant variety is indeed acclimatized—not by man, however, but by blind chance. You need not be unhappy, Mr. Cherabayev, over the idea of starting a controversy with certain persons (!!) who deny acclimatization; one has to bear with that, as the matter cannot possibly be elucidated without it; and evidently that was what the editor had in mind; otherwise, I imagine, your article would not have been printed. I certainly did not claim in my previous article that good foreign varieties should not be introduced in our parts. I only pointed out, on the basis of experience, that very few of them would prove suited to the northern and central areas of Russia, in view of the severe climate in these areas. I stated that a much more natural, easier and surer way to extend the assortment of each locality was to breed new varieties by planting the seeds of good fruits and giving the seedlings rational care. I endeavoured to show that a plant introduced from another climate in the form of seed and raised from it in the new locality will undoubtedly acclimatize and adapt itself to the new environment more easily than if transplanted in any other way. That, surely, is an indefeasible truth, and ought not to be contested.

Then, I wanted to refute the absurd belief that planting seeds, even of good fruits, never produces anything but wildings. You condemn me for advising that one should, without any elaborate pains, take for this purpose seeds of the best fruits on sale in neighbouring orchards, or even of fruits brought to local markets from other places; and you say it would be a surer method to take seeds from own-rooted trees. In regard to some species and to long-standing variations or such as have acquired full constancy, I agree. Seeds from such own-rooted individuals will yield a larger percentage of good seedlings. But where is the private gardener to find such trees? And if he does find them, how much time will be wasted until they attain fruiting age! Then, too, how is each grower to know which are the constant varieties? Whose directions is he to follow? For this is a matter which has not been elucidated at all as yet.

Which varieties are likely to be constant, in what kinds of soil and locality, and in the neighbourhood of what other varieties?

Even Mr. Grell, to whom you refer, only endeavoured to collect information in order to clear up this point; but unfortunately, he did not accomplish anything, as I know from his own letters to myself. His recommendations were based on conjecture alone.

I do not deny the usefulness of these recommendations for people of experience, people who are in a position to test this surer method, as you call it, for themselves.

In particular, it would be of great advantage to the progress of horticulture if our recognized scientists were to make a study of this matter; if, for example, they were at least to marshal factual evidence on both sides of the case, and communicate it through the press.

But for the general run of gardeners to accept these methods, which have not been tested in practice, as the established standard, and intrude a needless and severe retarding factor, is, to my mind, at least inadvisable; and if only for this reason, I thought it would be well to call attention to the simpler and easier way by which nearly all the fruit varieties existing both here in Russia and abroad have been obtained.

You complain that our Russian writers on the subject, and with them the fervent adherents of the method of propagation from seed, have not produced anything as yet.

But then perhaps you will explain how cultivated fruit varieties were obtained by mankind on this earth generally. Not, surely, by acclimatization from other planets?

I do not think I need labour the point any further. Everybody knows that all varieties of fruit trees, both here and abroad, were obtained by planting the seeds. . . . In this country, work is not appreciated, the opinions of the people who work do not come first; and as a result, our specialized publications are largely filled with high-sounding phrases and long words which the majority of readers have difficulty in understanding—assimilation, acclimatization, transthecration, and so on—and thrown in for good measure is a conjecture or scientific deduction based on some theory evolved by the author without any practical proof whatever.

And, you know, it is all so cunningly disposed in the article that the author's total ignorance of the subject is tucked away neatly behind a nebulous vagueness. Now most of our people have not much education, and what they need is directions about easier methods, set forth as simply as possible; and, above all, they need methods that have already been tried and sufficiently proved by practice, and not conjectures such as that a wild stock does not influence the variety grafted onto it, when it is an undeniable fact that it does.

We shall try to examine this question with all possible conscientiousness, and the author of the article about "The Failure of the Stock to Influence the Scion" must excuse us if we are compelled to disagree with his views.

No one will deny that the leaves do indeed serve to elaborate the sap imbibed by the roots; but to claim that the foliage is the only organ on which the qualities and structural differences of the fruits of all fruit plants depend, and that such a vitally important organ as the roots does not affect the structure of the plant as a whole and, specifically, of its fruits; and, moreover, to ascribe much greater influence to such relatively secondary factors in a plant's life as soil, climate and topographical conditions—to do that is not well, to say the least. The more so that facts encountered in practice do much to undermine belief in such theories. How, for example, is one to explain the following cases?

If a fruit bud of a good and long-standing cultivated variety is grafted onto a branch of a wild pear tree, and the following year, when the bud begins to develop, you remove the few leaves of the cultivated variety which usually appear in the vicinity of the flowers—the ovary, left under the influence of a mass of wilding leaves alone, will yet develop with only very slight deviations from the characters of the cultivated variety. The same thing happens in the nursery garden in the budding of apple trees, and particularly of cherry trees, when a fruit bud is grafted by accident instead of a growth bud. In the fruits of cherry trees produced in this way, very little change for the worse is to be observed. True, I may be told that, under the general law of the development of living organisms, the functions of the missing organ are taken over by another organ; in this case, by the petals of the flowers of the grafted fruit bud. Yes, one might assume that the petals, brief as had been their existence, had yet caused the rudiments of tissue to form in the ovary in the particular shape from which a fruit of the cultivated variety would develop normally thereafter. But I did not stop halfway in these experiments, I took the precaution of destroying the petals when the buds were first opening, and yet I succeeded—sometimes, though not always—in obtaining fully developed fruits.

Now surely one is not to assume that the functions of the eliminated leaves were in this case taken over by the stamens or pistils. That would be quite incredible.

On the other hand, if the cultivated variety grafted on in this way was a young, newly-evolved one, there were substantial changes for the worse in the shape and quality of the fruit.

Further, I took cuttings from several outwardly dissimilar, uncommonly vigorous selected first-year seedlings of cultivated varieties, and bark-grafted them the very first summer onto branches in the crown of a ten-year-old wild apple tree—all the leaves on the cuttings of course being removed. And what did I see? During the very next year of growth, the leaves and the structure of the other parts of the scions underwent an astounding change, although all wild shoots without exception were carefully removed when they first appeared and no influence could accordingly be exercised by leaves of the wilding. Firstly, the shoots and leaves on the different scions showed little dissimilarity as regards appearance and shape, and, secondly, all of them resembled in structure not the selected seedlings from which the scions had been taken—and which continued to develop vigorously in this second year of their life—but bore a striking resemblance to the wilding onto which they had been grafted.

Many such experiments were made, and if not all, yet the greater part of them prove beyond dispute that the stock does influence the scion. There emerged only a difference in the degree of influence, namely, the older the grafted variety, the greater its individual resistance to change, and the younger and less change-resistant the stock, the less does the influence of the latter upon the former make itself felt, dwindling in some cases to barely noticeable indications.

If, on the other hand, we take a variety, which, though old, is susceptible to change, or one that is young, insufficiently mature and not yet firmly stabilized, and graft this variety onto an older or more change-resistant stock, marked alterations due to the influence of the stock will not be slow to appear in the properties of the scion.

To return again to Mr. Cherabayev's article. As proof of the constancy of stone-fruit varieties, he quotes the example of a surviving twelve-year-old sweet-cherry seedling of Mr. Grell's. I perceive no proof here, as no information is given either about the seedling itself or about the variety from whose fruit it was produced. That in the first place; secondly, on the basis of experience, I positively declare that practically all sweet-cherry varieties, of all others, are in the highest degree unstable. I have several dozen such adult sweet-cherry trees, and they bear fruit, but not one of them has shown itself to be constant.

Mr. Cherabayev also says it would be interesting to know what would come of planting the stones of the own-rooted tree he mentions. Nothing of any worth in respect of hardiness, I make bold to assure him; but if Mr. Cherabayev should succeed in rearing even a single seedling to fruiting age, and plant the stones of that, then in this second generation he would get a high proportion of hardy individuals, as characters are transmitted to progeny mostly not from the father and mother, but from the grandfather and grandmother; this latter peculiarity in the transmission of hereditary characters is the source of the principal difficulty in the proper selection of parent plants for hybridization.

First published in 1905 in
Sadovodstvo i Ogorodnichestvo,
No. 14

HOW PLANTS CAN BE ACCLIMATIZED

After twenty-eight years' experience in cultivating fruit trees in the Tambov Province, I am in a position to say that plants can be acclimatized only by planting the seeds.

No foreign variety, if not already able in its native environment to endure temperatures as low as the minimum temperature of its new home, can be acclimatized by transplanting complete specimens, cuttings, layers, and so on. Attempts made along these lines are for the most part failures: such a variety may survive for a year or two, sometimes even for several years, but in the end it perishes all the same.

Every plant has the faculty of altering its constitution, adapting itself in the early stages of its life to new environmental conditions. But this faculty manifests itself in greatest degree in the first few days after germination; then it diminishes; and after the first two, three, or occasionally five, years of fruiting, it gradually disappears. Thereafter the newly-obtained variety becomes so resistant to change in the direction of greater hardiness that any methods of acclimatization are practically out of the question. That is why

I say one should not entertain the false hope that a variety which has once shown itself too delicate for the locality in question can be acclimatized by grafting it upon a cold-resistant stock; for the only result will be waste of time, money and effort. I am no follower of the beaten track, and certainly do not mean by this that one should renounce efforts to grow better varieties of fruit trees, and should only plant what our fathers and grandfathers did. On the contrary, I maintain that it should be our common endeavour to secure an improvement as regards both the quality and the number of varieties in each locality.

I may be told that the climate and other local conditions allow of nothing better.

I repeat, on the basis of twenty-eight years' experience, that this is the completest delusion. Of course one should not forego trying out novelties of foreign origin in order to extend the assortment in a particular locality. But do not forget that very little is accomplished in this way, because the climatic conditions in the native countries of these varieties are so very different from ours. The only varieties suitable for the purpose will be those which were already able in their native parts to endure temperatures as low as ours and to make do with less warmth for ripening their fruits. It only remains for us to collect and make known the fine varieties, possessed by certain growers, which resulted from the germination of a chance seed cast on the ground or from the offshoot of a stock. Next we should turn to the surest and most reliable method of obtaining new varieties—the planting of seeds from selected fruits of the best varieties, both native and foreign.

I repeat, the seeds to plant for this purpose must be only of the finest cultivated types, not of wildings of our forest varieties or of such as have run wild. If the latter are used, nothing of any worth can come of it.

It is futile to strive for or expect a good variety in seedlings raised from sour wildings, though there be a whole million of them.

Nature makes no such leaps, improvement is gradual, and so from an improved sour variety a further improvement can be secured.

Now of course one might in time achieve the desired result by this procedure too, but it would take too long, and what do we want with it? Why should we again go over old ground?

We already have the product of progressive improvement, namely, good cultivated varieties.

Theirs are the seeds to plant, whenever the opportunity presents itself, and be sure, your efforts will not be wasted in the end. Do not think that in order to obtain a good, and sometimes a really excellent new variety, a mass of seeds is required. It is not quantity that decides here, it is quality. Plant some hundred or two hundred selected seeds from the best fruits of a good variety, nurture the seedlings carefully, and you will have more than if you were to raise whole millions of seedlings from all manner of worthless seeds. Take no heed of the statements which have recently appeared in the press, telling us that, in the desire to find a good new variety, people had

the patience to examine millions of apple seedlings—and found nothing useful or worthy of attention.

I would wish to point out in this connection that these millions of seedlings were by no means raised for the purpose of breeding good varieties, but solely as wildings for grafting-stock; and that, accordingly, the seeds were not taken from good types, but from sour forest and similar semiwild varieties—a point which the writer omits to mention.

In setting forth my views on this latter subject, I know that I shall be inviting the shafts of many, but that cannot be helped. A new trend always encounters in its path whole masses of inveterate mildewed prejudices, unconscionable ignorance and ingrained intolerance among the mere copiers. But incontrovertible facts are on my side, bearing out what I have said. These facts are the new apple, pear, cherry and plum varieties which I and others have produced and which can freely stand comparison with the best foreign varieties. I hope in the none-too-distant future to obtain many more good acclimatized varieties.

First published in 1905 in
Sadovodstvo i Ogorodnichestvo,
Nos. 2 and 3

MY EXPERIMENTS IN BREEDING NEW PLUM VARIETIES IN A SEVERE CLIMATE

Very nearly the only completely hardy species of the plum group in our parts is, as is commonly known, the blackthorn (*Prunus spinosa*). It not only grows and bears abundant fruit in the forests of Central Russia, but makes its way far to the North, withstanding temperatures as low as -38° R., and, not being capricious as to soil, contents itself in some places with meagre and dry sandy loam. Only in years when morning frosts in the late spring kill its early-developing flowers does the blackthorn remain without fruit; unfortunately, such instances are common not only in the North, but in my locality too. This was the case in the spring of 1888, when late frosts killed all the flowers of the wild blackthorn in the neighbouring forest; but in my nursery, in a bed of three-year-old blackthorn seedlings, one tree of particularly compact low growth (not more than three-quarters of an arshin), and with a fairly wide and dense crown, put forth a mass of flowers which endured the morning frosts very well and set fruit abundantly. In the autumn, all the fruits matured.[1] Such abundant and remarkably early fruiting, and

[1] The stones were planted, came up very well and produced a new hardy variety, which, in addition to all the usual qualities of blackthorn, is remarkable because its flowers can survive morning frosts and because it can make do with dry, sandy soils, bears generous crops of fruit every year, and has no root growth. The fruits are smaller than those of the common blackthorn, their flesh has a less astringent taste, the stones are slightly elongated and difficult to distinguish from those of the cherry.

particularly the ability of the flowers to withstand morning frosts, naturally attracted my attention.

In the spring of 1889, I hastened to take advantage of the second flowering of my blackthorn, expecting,[1] not without reason, that a young plant, which had not yet had time to develop resistance to fertilization with pollen of a distantly-related variety, would be easier to fertilize as I desired with pollen of Green Reine Claude. I had in a basket at this time a small grafted specimen of the true Green Reine Claude, with flower buds. Unfortunately, this specimen, though placed in a protected spot well warmed by the sun, was later in flowering than the blackthorn, so that when the Reine Claude pollen was fully ripe, there remained on the blackthorn no more than fifteen flowers suitable for pollination. These were carefully castrated while still half-open, and afterwards fertilized with pollen from the Reine Claude. I should remark here that I had made similar attempts to cross Green Reine Claude with the blackthorn several times before, but had never succeeded, probably because of the too-distant kinship between the two. This time, however, twelve fruits resulted, which differed in appearance from the non-hybrid fruits only in a barely noticeable increase of the transverse diameter; as to their colouring, rind and taste of the flesh, I was not able to perceive any difference.[2] The stones of these hybrid fruits, on the other hand, revealed to the trained eye a clearly perceptible modification, particularly in the form of the stone's ventral seam and in a peculiar roughness of its surface. Unfortunately, I cannot recall the exact details at this date, and I was not able to make an accurate enough drawing of them to be of any use to the hybridizer: the developmental features were so very fine that I could not reproduce them on paper. (It is not what I have now in the stones of *Amygdalus sibirica*, a special form which I have hybridized with *Amygdalus Davidiana*, for the purpose of further crossing with cultivated and seed-propagated varieties of *Amygdalus Persica*. Here you have both stones five times the former size and the traces of hybridization standing out so distinctly that there has been no difficulty in setting them down in a drawing.)

When planting the stones at that time, I did not think, through inexpe-

[1] I would advise breeders to note, in order to avoid failures when making distant crosses, that it is well to take young seed plants in the first years of their fruiting, or better still, young hybrid plants, as these have been completely shaken out of their stubborn generic, hereditary resistance to pollination with an alien, uncongenial pollen. I do not mean to say that if this is done, all and every cross will be possible, but I repeat, under such conditions good results are more likely.

[2] All the same, hybridization does change the fruit, and I have always noticed it, if not with the naked eye, then with the aid of a magnifying glass. For the most part, of course, these changes are barely perceptible, but it does happen that they are so strongly manifested as to be immediately apparent even to the layman. Here is a striking example: when *Rosa rugosa* was fertilized with pollen from *Rosa bifera* (Mr. Bonsen's variety), the resultant fruits were of a high, bulbous shape, instead of a flat, turniplike one.

rience, to break them first,[1] and obtained only four plants from the lot. These I set out the following spring in loamy soil, in an absolutely open and dry spot,[2] with subsoil water only at a depth of 22 arshins. Here they remained without transplanting[3] until 1899, and showed themselves definitely hardy.

In the fourth year (from germination), one of the seedlings, the lowest in stature, bore the first fruit, but of very poor quality—evidently it had deviated entirely in the direction of the blackthorn, and so I had it destroyed.[4] In the fifth year, a second seedling fruited; I afterwards named it the Myasnaya Sliva [Meat Plum], on account of the specific taste of the fruits.

I should mention here that from the third seedling, whose leaves had the greatest similarity in appearance to those of Green Reine Claude, buds had been grafted in 1891 (that is, in the second year of its life) onto the neck of a three-year-old seedling of true blackthorn.[5] This graft was rather backward in the development of all its parts, and changed noticeably for the

[1] It is essential, as I afterwards found, to break the stones in the early spring before germination time, because in crosses in general, and particularly in distant crosses, you get relatively abnormal or positively monstrous seeds and stones, in most cases incapable, when germinating, of opening of themselves, without human assistance. I have had occasion, when a long time passed without sprouts appearing, to open the stones; and what did I see? The seed had sprouted and, finding no exit, had wound itself around the cotyledons or grown into them. The same should be done in such cases with cherries, plums, peaches, apricots and roses.

[2] In my eagerness to secure hardier varieties, I evidently overdid this Spartan training, and thereby worsened the qualities of the new varieties' fruits, which under other conditions would probably have been better, while hardiness in all likelihood would not have suffered either, in view of the predominant, as it turned out, influence of the blackthorn. In general, my subsequent researches made it quite clear that seedlings should be reared in as fertile a soil as possible, particularly where it is desired, in compliance with human taste, to train a plant with an overdeveloped pericarp—a thing that undoubtedly does not accord with the laws of Nature.

For the latter, such plants are nothing but monsters, and Nature will not foster such abnormal deviations—that is something man must do, by duly intensified nourishment, which must, in order to make the deviation permanent, be kept up all the time until the plant attains complete maturity. If artificial nourishment is withheld even for a time, the plant retrogresses.

[3] I do not know if I am right, but, as distinct from the treatment of pome seedlings (which need to be frequently transplanted), I still avoid undue transplanting of stone-fruit seedlings, for I have noticed that it hinders the progressive improvement of the various parts of the plant in the course of its growth to maturity.

[4] It is a gross error to condemn a plant on the basis of the qualities of its first fruits; as subsequent work with stone-fruit seedlings—and also with pome seedlings, particularly hybrid ones—showed that if they are given good care, the qualities of the fruits improve gradually in the first few years, though cases of retrogressive development have also occurred.

[5] One should not make grafts onto a wilding from a young seed plant, particularly a hybrid one, without carefully considering the choice of the stock; as such a scion, taken from a plant that has not yet developed sufficient stability—which is only attained

worse as time went on. It bore fruit in 1896. And, finally, in 1898 (that is, in the ninth year) the first fruits were also borne by the third seedling itself, which I had named Reine Claude Ternovy. It is from this seedling, as I have mentioned above, that the grafting was made.

And here I observed highly interesting manifestations of the influence of a stable true-blackthorn stock upon a young hybrid variety grafted onto it, and also progressive development in the fruit qualities of the own-rooted original of the hybrid. The fruits of the original improved gradually in both size and taste; the fruits of the graft, on the other hand, deteriorated in every feature year by year. Moreover, its shoots lost their pubescence, the leaf shape changed from roundish to oblong, and the leaf margin from crenate to serrate. Noteworthy, too, is the fact that this retrogression turned out to be completely permanent, as may be seen from the following. When my whole nursery, with its already adult seed-grown trees, was moved to a new plot of land in 1899, I had to transplant the ten-year-old blackthorn

at complete maturity—will be laid open to the influence of a blackthorn type which. though also young, is a pure, non-hybrid species, with hereditary, relatively greater stability in its vital functions; and under this influence, the young plant is bound to deteriorate, especially as regards the qualities of its fruit. I have observed this not only in new varieties which I raised from seed, but even in certain long-standing varieties of apples, pears, cherries and plums—though of course in less pronounced degree. It is to this phenomenon, too, that I attribute the individual instances of apparent acclimatization of old foreign fruit-tree varieties from the West. The whole secret here is that the definitely tender old type happened to be grafted onto a stock with an exceptional individual power of subordinating even a long-standing and fully-formed variety to its influence.

I say "apparent" acclimatization because, though not always, yet in the overwhelming majority of cases, such an acclimatized variety loses its acquired hardiness when transferred to other stocks, and perishes of the cold. True, there are cases, though very few, of a tender variety retaining hardiness permanently: but when that happens, the plant changes so much that its fruits become totally dissimilar in taste to the fine western variety taken for acclimatization, and this change is always for the worse. What sort of acclimatization is that, may I ask? Why, what we get in a case like that is, in effect, a totally different variety.

On the basis of all this, I definitely do not advise trying to hasten fruiting in young seed plants by grafting them thoughtlessly onto the crown of the first wilding that comes to hand. Now to make grafts onto the crown of strong cultivated varieties—always bearing in mind their future influence upon the scion—should, I believe, prove useful.

In general, problems so important to horticultural development as rules for the judicious breeding of new fruit varieties by propagation from seed and as the influence of the stock on the resultant seedlings have unfortunately been very little investigated, and not only here in Russia, but even in Western Europe. If in specialized publications one does come across individual attempts to deal with the matter, one can nearly always see, in my opinion, that the writers proceeded for the most part in blindfold fashion, trusting to luck, and sometimes totally disregarding the most important aspects of the subject—some out of ignorance, others simply out of opinionated self-conceit, acting on false preconceived

hybrids with the rest; and the grafted specimen I deliberately planted much deeper, with the grafting point below ground, and, by maintaining the moisture supply, induced it to send forth roots from the thickening which already existed at the grafting point. By the summer of 1903 these roots had attained almost complete development. Yet the fruits of the 1903 and 1904 crops were of just the same kind, showing no improvement whatever. In a word, it is just as if we were dealing with two totally different varieties.

The fourth and last seedling perished during the transplanting of 1899 without having borne fruit.

From the Reine Claude Ternovy variety I have a three-year-old second-generation seedling, obtained by a second cross with Green Reine Claude. All parts of this seedling show an improvement, but there has been no fruit as yet.

I have gone into such a detailed account of the hybridization and training of these blackthorn seedlings only in order to give the reader as clear an idea as possible of what should be done to extend the culture of southern plants to the north, and also of what mistakes were committed, and what

notions, others still, because they are afraid of a little extra work. Lastly, there are also individuals who simply reject, with unaccountable savage violence, even the already ascertained facts of this matter. And yet it is quite evident of what inestimable benefit it would be to elucidate these questions. . . . Of course, the limited space of horticultural periodicals does not allow of much material being brought together in them—that would require too much room. It would require a special volume—a thing which today, when life is so hard for the labouring man, is quite impossible of realization without substantial financial assistance from the state. But still, there are people who are working, who have been observing these things intelligently, and who, consequently, have made many useful observations. Why not make these observations known in printed form? It is exceedingly probable that the marshalling of such information, even though brief and fragmentary, would be of material future benefit, if only because it would prepare the material. . . . After all, one cannot cling for ever to the same varieties, to the same methods of culture. What was good and even profitable before may easily prove worthless at a later date. Our forefathers turned up the soil with the wooden plough—while in our day a real plough is already a necessity.

Perhaps some will retort with the question, how much have I myself done? How many varieties of present-day benefit have I bred? Granted, I have done little. But then much cannot be asked of me, a man of limited means, living by his own labour. I do not want to say that my means are insufficient for my private expenses—for that I have enough; but they are insufficient for conducting the work on an extensive scale and solving problems in a big way. For the good of the future, sums more than considerable are required; and as the task is a vast one, this is, to my mind, a matter for the Treasury and the state.

And so let me not be reproached with having done little. What I could and as I could, I did, and shall continue to do in future, if not prevented by circumstances.

Coming back to the question of breeding new varieties, let me say that it is altogether essential to found a government institution for hybridization work, if only one for the whole of Russia—it would bring our state untold benefits.

were the results. In other hybridization work with both stone fruits (cherries, plums, apricots, peaches) and pomes (apples, pears, mountain ash), and also with roses, the findings, with minor exceptions, were the same. It is otherwise in the case of small fruits—raspberries, gooseberries, currants, and so on; here there is a big difference. In my next article, I shall give a detailed description of the more noteworthy seedlings I have obtained by hybridization, and shall append photographs.

First published in 1905 in
*Progressivnoye Sadovodstvo
i Ogorodnichestvo*, No. 4

MY EXPERIMENTS IN BREEDING NEW VARIETIES OF FRUIT PLANTS

I began my experiments in testing and hybridization of fruit plants in 1875. Since at that time I lacked thorough knowledge as regards the selection of fruit-plant varieties, I decided to test and make a personal study of as large a number of varieties as possible, and to this end I ordered from many fruit-growing establishments in Russia and from some abroad over six hundred different species and varieties of fruit and decorative plants. But soon enough, as might have been expected, this "assemblage" resulted in a host of disappointments. Firstly, there was every reason to suspect confusion even on account of external appearance alone, of the shapes of shoots and foliage, which sharply differed in saplings of the same variety but received from different places. As a matter of fact, this confusion subsequently became manifest. Secondly, after the very first winter, which, as ill luck would have it, was especially severe, I had to eliminate from the collection more than half of all the varieties, as having definitely proved to lack hardiness. Then, after a few warm winters, there came other severe winters, with more losses. The result was that hardly one-tenth of the entire large collection survived, and this consisted, with few exceptions, of Russian varieties of the most ordinary kind as regards the flavour of their fruits.

The losses were biggest in the pear, cherry and plum varieties, of which only a miserable few survived. Thus, out of 150 strains of pears there survived the Bessemyanka, Tonkovetka, Tsarskaya and two varieties of Bergamotte; out of sixty strains of sour cherries, there survived the Vladimirskaya and Ostheim, and out of seventy-five strains of plums only the Ochakovskaya Belaya and several semicultivated varieties survived; of twenty varieties of sweet cherry not one survived; of thirty strains of gooseberry twenty perished; of fifteen varieties of blackberry three endured.

The apples suffered relatively less: only two-thirds of the two hundred varieties perished. But of those that survived, with the exception of two or three varieties from the West and several select Russian strains, with the Antonovka heading the list, many proved to be very middling as regards flavour.

...In view of such enormous losses, and since I would not rest content with the remnants of the collection, I naturally began to devise means of combating the severe conditions. I made several excursions to various places in the central and northern sections of Russia with the aim of becoming more closely and personally acquainted both with the way fruit growing was carried on in those localities in general, and, in particular, with outstanding horticulturists and their work. Incidentally, I hoped to obtain from them some especially sturdy good varieties which had been bred by them or which happened to grow in their parts. I started an extensive correspondence on the same subject with amateurs. But, unfortunately, I obtained very little by those means; of apples, for example, I acquired about fifteen varieties, of which I enumerate the following as the most outstanding in respect of quality: Romer Rosmarin Russky, Romer Sinap, Romer Zelyonka, Borovinka Novaya, large-sized Skrizhapel, Skrizhapel Sharlakhovy, Zolotoye Semechko, Vinogradnoye, Reshetnikov Soroka Samarskaya, Reshetnikov Reinette, Kopylov Seyanets Chornovo Dereva, Kopylov Seyanets Babushkina, etc.; of pears: Kaluzhanka, Medvedevka, Myasoyedovka, Bergamotte Zelyony Vynoslivy, Rulyovka, etc.; of sour cherries: Zakharovka, Sibirskaya; of plums: Progress, and Kuzminskaya from Vetluga; gooseberries: Anibud and Kuzminsky from Vetluga.

But all that was, of course, insufficient and—above all—I did not like to give up the idea of having in my possession foreign strains with fruits of such attractive appearance and flavour. Sustained in those days by the advice of Mr. Grell, I began, in line with his theory, to try to acclimatize delicate varieties by grafting them on to hardy stocks. Simultaneously various auxiliary methods were employed—methods cunning in theory, but almost always useless in practice, namely, pinching off of shoots, removal of part of the foliage at the end of the summer, introduction of lime into the soil, keeping extra moisture away from the roots in the second half of the summer, etc. But nothing was achieved by all this—the foreign varieties obstinately refused to reconcile themselves to the climate in our section of the country. There were rare exceptions when it seemed that we had achieved success, but that was a delusion. For example, by grafting ten-year-old wildings of pears on to the crown I managed to preserve a few dozen of foreign Beurré strains, and they bore fruit for several years. I sincerely believed that this was a real success and, at the insistence of Professor Rudzsky I rushed into print with an article describing this speedy acclimatization, which was published in the magazine *Vestnik Sadovodstva i Ogorodnichestva* for 1888, p. 395. But soon the error came to light. Firstly, it turned out that when such acclimatized varieties were transferred for grafting at the nursery garden they no longer manifested endurance; secondly, the trees themselves, on to whose crowns these varieties were grafted,[1] gradually began to dry

[1] Apparently owing to the fact that the time of the beginning and of the end of the movement of sap in the stock and in the grafted sorts did not coincide.

up somehow and to lose branch after branch, and in the end they perished completely.

True, in my search for methods of acclimatization I did succeed, not without benefit to all, in clarifying one phenomenon of what might be regarded as real acclimatization. This is apparently a happy coincidence, when a delicate strain happens to be grafted on to such a hardy stock as possesses the individual capacity of influencing only this particular variety grafted on to it, so as to alter its hardiness. Such ostensibly acclimatized—always solitary—individuals, which I happened to find and which happened to be found by other horticulturists, are the main cause of the error into which the votaries of acclimatization fall; for although these—solitary, I repeat—individuals grow and even bear fruit apparently satisfactorily, the error becomes manifest at the first attempt to propagate such pseudoacclimatized strains by grafting them on to other stocks, because then no hardiness is observed in the other grafted individuals. And, vice versa, if the same stock, on which one variety proved hardy, is employed as host for another variety, the hardiness will not be transmitted to the latter. While I do not in general deny the benefit of using hardy stocks, I am nevertheless convinced that no appreciable success in acclimatization can be attained by this means. I therefore had to turn to the last and—as transpired later—the surest method of increasing the assortment of fruit plants, namely, breeding new local varieties by using seed of the best varieties, both our own and foreign, particularly seed obtained by artificial crossbreeding. I must note here that already in 1884, while I was still employing Grell's methods of acclimatization, I began to make a thorough and extensive study of hybridization, because I was quite aware even then that by artificial crossing of choice delicate foreign strains with our local hardy strains it is possible, by sowing the hybrid seed thus obtained, to produce new varieties, with better fruit, which could endure in our parts. Fortunately there were some choice parent saplings for hybridization available, because in 1885, when rescuing some still surviving trees of foreign strains on dwarfing stocks from final destruction, I transplanted them partly into places protected during the winter, and partly directly into baskets which I also removed to where they would be protected.

And so, in 1888, many of these saplings flowered and made it possible to start crossing in considerable quantities. In most cases the fertilization proved successful, and the seed from the fruit which, after the crossing, set and ripened, were sown again into boxes, some in the autumn and some in the winter—depending on when the fruits ripened. In the spring the sprouts of the crossbreds[1] were pricked out into the beds, with the names of the

[1] A crossbred is a seedling obtained by crossing varieties of the same species, whereas a hybrid is a seedling obtained by crossing plants of different species. Michurin, however, did not regard it as essential strictly to follow this terminology, as is evident from the following entry in one of his diaries: "It has long been known to all that we describe as hybrids all seedlings, without exception, which have been obtained by crossing

parent strains carefully noted on zinc tags. In the first year, 1889, I obtained about five hundred seedlings in all. Hybridization and planting have been going on in all the subsequent years since then to this day.

After twenty years of effort, after a persistent and thorough study of everything pertaining to this subject, I have, firstly, succeeded in completely refuting the erroneous opinion, so deeply rooted among fruit growers, even among diplomaed horticulturists, that as a rule only wildings are obtained from seedlings produced even from the seed of the best varieties of fruit trees, and that, even if a good new variety is obtained by such means, it is but a fortunate accident so rare that it is positively a waste of time to try. Secondly, and most important, I have found the reason why it was mostly wildings that were obtained after planting, and have succeeded in ascertaining what should be done to obtain as high a percentage as possible of new good varieties suitable for cultivation, capable of yielding fruit that are better in appearance and flavour.

The main task, as it turns out, is to observe the following conditions:

1. Choose varieties from the seeds of which the largest possible percentage of seedlings with the required good qualities may be obtained, preference always being given to fruits from orchards in which there are no wild specimens of the same species.
2. Select the best fruits as regards external and internal qualities, i.e., avoid fruits of an ugly form, diseased, puny, etc.
3. Select more correctly formed and fuller seeds.
4. Under no circumstances allow the seeds to overdry either before or after planting.
5. Provide soil of the proper composition for each species of fruit plants and in some cases even for individual natural varieties and strains.
6. Proper care in training the seedlings, with a view exclusively to the most luxuriant possible development of all the parts of the plant. It is absolutely essential to prevent, during the vegetation period, any, even if only temporary, insufficiency of moisture in the soil, to prevent the soil from growing too compact, from being infested with weeds, from becoming exhausted. This kind of care should be provided for the nursling up to the first two or three years of bearing, i.e., until it has grown strong enough and has acquired sufficient stability against regressive deviation.

two different species of plants; for example, seedlings obtained by crossing the *Pyrus prunifolia* with a cultivated variety of orchard apple—Antonovka, Borovinka, Anis, etc.—will always be called hybrids, even though they are devoid of any substantial distinctions and even though they subsequently do not prove to be stable in their characteristics. On the other hand, seedlings produced by crossing varieties of the same species, for example, the Antonovka, the Borovinka, the Anis, are called crossbreds. Actually, it is only our pseudo-learned botanists that need all this tomfoolery; as far as we practical horticulturists are concerned, it makes no whit of a difference whether it is called a hybrid or a crossbred."—*Ed.*

The above six conditions contain the principal points by which one should be guided in growing new varieties from seed without hybridization. Afterwards, if an opportunity is offered to introduce artificial crossing as well, which increases the chances of success, the following points should also be taken into consideration:

7. As far as possible choose young varieties for both components, as the more capable of producing better crossbreds. The individual plants should also be young and vigorous, not diseased and feeble.

8. To prevent self-pollination of the flowers of the maternal plant it is necessary to perform the castration operation on buds just beginning to blossom. After the artificial fertilization, the pollinated flowers should be protected with white gauze against undesirable pollen which may be accidentally conveyed by the wind or by insects from other varieties, particularly from wild varieties, as all cultivated strains have a strong affinity for being fertilized by them.

9. All the time, from the moment the fruits set until they ripen, it is necessary, as far as possible, to provide extra nourishment for the maternal plant, to prevent the soil beneath it from growing too dry, and to remove the setting fruit which were not included among those pollinated.

10. Where possible it is best to use as the maternal plant one of a variety which is hardy in the given locality and one that is not grafted but is standing on its own roots. This is highly beneficial, as it eliminates the influence of a wild stock on the formation of the seed and, consequently, also of the future seedlings.[1]

I must say in conclusion that it should not be assumed that the painstaking work of artificial crossing, from which many shrink, is absolutely necessary in the breeding of new varieties from seeds. It only increases the chances of success and there are certain advantages to be derived from it, because it makes it possible to use discretion in the mating of parental pairs. But the latter does not always give the sought-for results, because the hybridizer can by no means calculate beforehand that he is going to get a strain with such and such qualities constituting a combination of the crossed strains. Such calculation is erroneous, it is possible only in theory; in practice, the results are quite different. Thus, in the overwhelming majority of cases crosses represent a combination, not of the immediate and closest progenitors, i.e., of the father and mother, but of grandfathers and grandmothers. And since in the majority of cases the qualities of the latter are unknown to us, the advantages of a skilful choice of parents are largely lost; and, if we take into account the fact that with the introduction of hybridization the task becomes many times more complicated and to many persons practically

[1] I have at present in my orchard a pear tree produced from seeds in which the mentioned influence is so pronounced that even the differences in the bark and in the slanting of the woody fibres (knottiness) usually observable in the case of grafting are copied so exactly that, without knowing the facts, it is hard to distinguish the specimen from a grafted tree.

unattainable, whereas the ordinary method, granted proper care is provided for the training of the seedlings, yields just as good result, it is obvious that one can, without much injury to the work, confine oneself to merely sowing seeds collected from ordinary fruits, even purchased ones.

... In 1893, in order to put the work on a broader basis, I was compelled, in view of the extra expenses required, to open a small commercial nursery, selling one- and two-year-old unformed saplings. This nursery is being maintained to this day with the sole aim of providing the opportunity for me to conduct scientific experiments.

First published in 1906 in
Progressivnoye Sadovodstvo i Ogorodnichestvo,
Nos. 12, 13, 14 and 15

CONCERNING CERTAIN ANSWERS AND ARTICLES IN THIS MAGAZINE

In the "Questions and Answers" section of *Progressivnoye Sadovodstvo i Ogorodnichestvo*, No. 19, readers are invited to send in corrections to the answers given, if these appear to them to be mistaken. Finding such an approach to be of the greatest value for a fuller and more comprehensive elucidation of various misapprehensions in horticultural matters, I am very grateful to the editor for having initiated a practice so exceedingly well adapted to stimulate the development of horticulture, and respond gladly to this invitation.

In answer No. 994 (issue No. 19) it is claimed that the Drogan Yellow and Dönissen's Yellow sweet cherries can winter without cover in the Oryol and even the Tambov Province (I pass over the Tula and Moscow provinces, which are also mentioned in this answer). Such answers, it seems to me, can cause inexperienced gardeners much irretrievable loss.

In our Tambov Province, for example, not only sweet-cherry trees, but even ordinary sour cherries, such as Early Natte, Kent, Early Morello, Late Morello, Sklyanka, and for that matter practically all foreign varieties, cannot survive the cold; there are only some three or four exceptions, such as the Griotte d'Ostheim, the Late Natte, and also various local varieties figuring under the name of Vladimirskaya.

It was this circumstance that compelled me to undertake the breeding of new hardy varieties by crossing.

Consider, where will you meet in the Tambov, Tula or Moscow provinces commercial orchards, of even small size, planted with Nattes and Morellos of various kinds and yielding good crops? There are and can be none. And here we are suddenly told that well-known old sweet-cherry varieties can grow in our parts without coming to any harm.

Do not believe it. I have tried, and nothing good came of it. Sometimes such a tree will manage to live for three or four years and yield a crop in a good year, but then it perishes all the same.

It has happened that the tree itself has held on for as long as eight years, but the fruit buds can survive only in exceptionally warm winters. Bandaging does not help. And there is no point to keeping such trees as decorative plants, without fruit.

Be sure, if it were possible to grow such varieties safely in our Tambov Province, or even in the Kursk, Voronezh or Oryol provinces, there would be whole plantations of them, and the Crimea would very soon be faced with competition.

I have at the present time some twenty varieties of sweet cherries with fine fruits—I have bred them by planting the stones. These varieties are infinitely more hardy than all known sweet-cherry types of foreign origin; and yet I do not feel justified in recommending them freely for cultivation in the Tambov Province; we must wait until still hardier varieties appear from the seeds of the second and third generations.

In our town of Kozlov, the Investigating Magistrate, Mr. Kozhevnikov, is an enthusiastic grower of sweet cherries. Well, he contrived to bring through some fifty trees of the Drogan Yellow, and for twenty years enjoyed splendid crops of fruit from them.

But these results were only obtained by inclining the trees every year and covering them up with earth. Now that is a labour for the slaves of Egypt, and what is more, in the end all the trees perished just the same in the course of a single winter.

Next, ask the heirs of the well-known horticulturist F. Romer, who lived a long way west of the Tambov Province (in the Karachev District of the Oryol Province), whether he was able to raise any sweet-cherry varieties. When I visited Romer, he complained that even the seedlings of his sweet cherries were dying of the frost, one and all.

Then, ask Karlson in Voronezh—all his sweet-cherry trees perished too.

And as to what Mr. Cherabayev tells us about some sweet-cherry tree that has survived in Grell's acclimatization garden in Moscow—well, all manner of miracles happened there, only to go on the basis of them would be risky, to say the least, as I think many have found to be the case.

Lastly, I cannot understand why the editors did not think it necessary to make any comment on Mr. Cherabayev's article regarding the influence of the stock on the grafted variety. Just examine it, please, there is certainly something very incongruous about it. In his opinion, the stock has an influence on positively every part of the variety grafted onto it: on growth, on fruit bearing, on the shoots, on hardiness and, lastly, on the formation of the seed; yet, suddenly, an unexpected exception: when it comes to the quality of the fruit, he does not recognize this influence as operative. Say what you like, but it is hard to agree with this, all the more that this is not the way it works out in reality.

First published in 1907 in
Progressivnoye Sadovodstvo
***i Ogorodnichestvo*, No. 31**

PRODUCTION OF NEW CULTIVATED VARIETIES OF FRUIT TREES AND SHRUBS FROM SEED

Deep and attentive study in the course of my thirty-three years of practical work on various orchard cultures in the central belt of Russia has led me to the conclusion that in the development of this work we are at a very low level, since the quality and productivity of our cultivated plant varieties are much too unsatisfactory. Although many agriculturists, former owners of large plots, did in the old days endeavour to improve some particular assortment of plants, in most cases, unfortunately, the methods they chose for the attainment of their ends were altogether wrong. With very rare exceptions, each of them tried to acquire one or another variety which he considered more productive, but paid all too little attention to its place of origin, the result being that there appeared in our orchards a host of varieties of foreign origin which had originally been produced under entirely different climatic conditions, and consequently, in their majority, were unsuited to the new and unaccustomed environment. How much labour and money was spent on the application of sometimes fairly ingenious, but for the most part ridiculously naive, methods of acclimatization—that famous acclimatization!—yet in the end the results were nearly always bad. With very few exceptions, such forcibly transplanted varieties barely manage to carry on a wretched existence in our country, gradually sicken, and in the end perish altogether or degenerate to such a degree as to produce fruits which are far inferior in quality to those of our old local varieties. These foreigners all degenerate not only because of improper soil treatment, as is usually asserted, but chiefly because it is impossible artificially to provide these plants with those climatic conditions essential for their full development under the exclusive influence of which these varieties were created in their country of birth. For centuries, mark, we have been expending large sums of money and wasting time and labour bringing into our country different foreign varieties of Reinettes, Calvilles, Beurrés, Duchesses, Reine Claudes and similar treasures, and yet down to this day the Crimea and the western borderlands alone supply our city markets, and that only to an unsatisfactory extent, with fruits that are only wretched imitations of those we still obtain in enormous quantities from their real homelands, from abroad.

As to the middle areas of Northern and Central Russia, it is not even worth while talking about them. We still keep drudging over varieties which fate has chanced to send our way—the Antonovka, the Anis, various Repkas, Plodovitkas and practically the one sole edible variety of pear, Bessemyanka. Or take the sour cherries, for example. What valuable varieties have we of this, it would seem absolutely unfastidious but very profitable, fruit plant! Why, one can scarcely point to a single commercial orchard of sizable dimensions in Central Russia, not to speak of its northern part, that is planted with the various English, French and Dutch varieties of Morellos, Nattes, Griottes, etc., which are constantly recommended to us by our trade firms. Here again, you will find nothing of the sort anywhere,

with the exception of the western borderlands and the Crimea. Everywhere in the boundless expanses of Central Russia you will find only semiwild thickets, dumb witnesses to the fact that here there were once planted varieties of sour cherry obtained from abroad; but the foreigners failed to survive —in the first severe winters they perished to the last one. Shoots have sprung up from the surviving roots of the wild stocks, but even these cannot withstand every winter quite successfully, as a consequence of which the grower can rarely fetch a crop from them.

Then, one fairly often meets groves of the Vladimirskaya sour cherry. But this variety is good and productive only on the soil of the town of Vladimir and its immediate environs; in other places it produces very small fruit, and its yield is extremely poor. You will find a similar state of affairs, if not worse, with the cultivation of plums. Is this not sufficient proof of my contention regarding the poor quality of the varieties of plants we cultivate?. . .

It seems to me there cannot be two opinions on this matter. Many who agree with me will point to the stern climatic conditions of our region as an unavoidable cause of the imperfections of our horticulture I have enumerated. But this view is grossly mistaken; climate in this case becomes a big factor only if wrong methods are used. I repeat, climatic handicaps may be a hindrance only if it is endeavoured to introduce and acclimatize in our parts already finished varieties raised in foreign lands where climatic conditions are absolutely different. But if we use proper methods, and breed our own local varieties from seed, this hindrance recedes into the background. If plants are obtained in this way, employing hybridization and selection —those powerful and still insufficiently appreciated levers—adverse climatic factors lose a great deal of their influence, because plants bred in this way adapt and accustom themselves from the earliest stages of their development to the climatic conditions of their place of birth; they are, so to speak, created under the influence of these conditions, and the latter will therefore not be terrible to them. This is an axiom which demands no proof.

Further, to the question—do the climatic conditions of our parts permit the breeding of new varieties of plants, with fruits of better quality than those of our old varieties?—I, on the basis of my thirty-three years' work in this field, can confidently reply in the affirmative. Even a casual perusal of the articles I have printed in various horticultural periodicals in 1905, 1906, 1907, 1908, 1909 and 1910, describing new varieties of fruit plants produced by me from seed, should be enough to convince one that it is quite possible for us to have our own splendid varieties. And not only of the species of plants customary in our parts; there is even a well-founded hope of obtaining such as we, in our regions, could not formerly even think of cultivating in the open. We may boldly count on having in our orchards sweet cherry, grape, apricot, and lastly, maybe, even peach. But all this, I repeat, we can achieve only by producing new varieties of plants from seed, but not in any case by acclimatizing ready-made foreign varieties. . . .

In view of the widespread mistaken notion about the possibility of accli-

matizing fruit varieties produced in other countries, I find it necessary, on the basis of my personal experience, to say the following. The acclimatization of plants, in the full meaning of the word, is only achievable if the plants are propagated naturally, from seed.

No variety[1] of foreign origin, if already in its birthplace it did not have a latent capacity to withstand climatic conditions resembling those of our parts, can be acclimatized by transplanting finished plants, or cuttings, layers, etc., from them. All attempts to do so have for the most part failed. It sometimes happens that a variety undergoing acclimatization does survive for a year or two, sometimes even for several years; but in the end it perishes. And if in particularly favourable years such a variety forcibly implanted in our parts does yield a crop, its fruit, as regards taste qualities, is only a wretched imitation of what it was in its native land. Many have often been misled by the fact that when tender foreign varieties are grafted in our parts, some of them happened by chance to be grafted on stocks with outstanding individual properties, capable of partially modifying the constitution of the varieties grafted on them, lending them a rather greater resistance to frost. Such a tree will sometimes survive in our parts for a fairly long time, but if the owner should conceive the idea of using this fictitiously acclimatized variety for propagation, the mistake will at once become apparent, because the newly-grafted saplings will soon be killed by frost down to the last one.

Every plant possesses the faculty of modifying its constitution in adaptation to a new environment only at a young age. This faculty is most strongly manifested in the first days after the sprout has appeared from the seed, but with the lapse of time it gradually becomes feebler and finally disappears altogether when the tree reaches full maturity. After this the new variety of fruit tree becomes very resistant to change, in respect to hardiness, and no methods of acclimatization can now alter it. I therefore urge you not to be deceived by the false hope of acclimatizing any variety once it has proved to be unhardy in your parts, for it will only be a useless waste of time and labour.

Of course, in seeking to replenish the assortment of fruit plants in our parts, we must not altogether reject the testing of newcomers even of foreign origin; but I must warn that very little will be attained in this way, for the fact alone that the climatic conditions in the birthplaces of these varieties are extremely different from ours. I repeat, only those varieties will be suitable for our parts which already in their native land possessed the faculty of withstanding sharp drops of temperature similar to those which occur with us, of contenting themselves with a smaller sum-total of heat for the ripening of their fruits, of tolerating, without prejudice to healthy develop-

[1] All the hardy varieties of alien origin in our parts—e.g., of the apples: Aport, Babushkino, Skrizhapel, Rosenapfel, Eiser; of the pears: Malgorzhatka, Moldavskaya, Sapezhanka; of the sour cherries: Griotte d'Ostheim, etc.—proved to be frost-hardy in our parts, not because they were acclimatized but only because these varieties already possessed an especial quality of hardiness in their place of birth.

ment, the far greater dryness of atmosphere characteristic of all continental regions, and of being satisfied with a shorter vegetation period for the completion of all functions of growth.

Ponder, sirs, on all I have said, and you will realize that we should long ago have radically altered our obsolete and incorrect ideas regarding fruit growing in our parts. How much would we then have accomplished in removing the obstacles to the development and prosperity of fruit growing in Russia!...

Just think how increasingly necessary it becomes from year to year to combat the numerous and various plant pests that have multiplied on such an enormous scale, many of which, in fact the most malignant, have been imported together with the plants obtained from abroad. And with what astonishing speed are these pests multiplying in recent years!

It is my belief that it would be useful to study the cause of this phenomenon more closely. To attribute it all to lack of energy on the part of orchard owners in destroying the enemies of plants is, to say the least of it, unwise. Let us recall what was the state of our orchards fifty years ago. Who in those days had any idea of the means of combating fruit-plant pests which are known to us today? Yet the orchards were much less subject to pest ravages.... Of course, an indirect cause may be the noticeable change of climate and denudation of forests; but the chief culprits are undoubtedly we ourselves, who create a favourable basis for the multiplication of the enemies of plants. In the past fifty years, with the development of railways, it has become easily possible to obtain plants from other countries, even the remotest, and we, who so love everything foreign, are availing ourselves of this possibility to the full....

Besides directly importing, together with the plants, species of pests formerly unknown in our country, we have literally adulterated all our cultures with imported foreign varieties which, coming in contact with the unaccustomed climatic conditions of the new environment, were unable properly to develop, became enfeebled and sickly, and infected the local plants with their diseases, the result being a general debilitation of the greater part of our orchard plants, and this created a favourable basis for the rapid multiplication of pests.

In every struggle, one side always grows stronger at the expense of the other. So in this instance. It is becoming obvious that our cultivated plants are growing weaker and weaker every year; they are no longer able independently to withstand the onslaught of the various pests, to the degree, for instance, that our wild forest plants are able to, this being only because the varieties of the latter have evolved in the course of centuries, by natural selection of the strongest and fittest in the struggle for existence. This kind of selection we have absolutely not made use of in the breeding of our orchard plants, and, what is more, could not have made use of it, because we have never endeavoured to produce our own varieties by the natural way of sexual propagation from seed. Yet that is the only way the method of selection could be widely employed.

I myself, for example, have often been advised by sticklers for routine that it would be better to adhere to the old, tried and tested methods than to strive for the new and unknown. I find it necessary to say in answer to this that it is extremely unwise in any work, and in fact useless, to stand still in one place, to cling to a part when the whole is striving irresistibly forward. It is a futile effort, and only results in the complete destruction of the restrained part, because everything that is artificially forced to remain at a standstill is inevitably stricken from life. And, finally, even if we did manage to cling to our old varieties, they would in time lose their value all the same, if only because in the course of time the demands of the market change and become quite different, and what satisfied before may easily become unsuitable in the future. And this will only make for still greater imports of foreign horticultural products, which is, of course, highly undesirable, if only for the reason that every import of foodstuffs from abroad inevitably diminishes the financial resources of the country.

From all I have said it will be evident that we must, for the better development of our native horticulture, persistently strive to improve our assortment of fruit plants. But such improvement must be attained not by introducing foreign varieties, but exclusively by supplying every locality with its own varieties of fruit plants, which must be bred from seed in the given locality, under the constant influence of its climatic conditions. And it is, furthermore, necessary strictly to select from the new varieties only those which are distinguished by improved taste and appearance of the fruits, by annual yielding, and by full and unqualified resistance to local climatic handicaps.

Unfortunately, there is a long-standing belief among our horticulturists that if the seeds of cultivated varieties of fruit trees are planted, only seedlings of the wild type are obtained, and that if they are not grafted with cultivated varieties, they will grow into trees that bear worthless, sour fruit. Although it is true that in practice the results of such sowings do indeed seem to confirm the truth of this conviction, nevertheless I make bold to assure my readers that there is a profound error here, which when the matter is properly examined becomes quite obvious. I shall endeavour in this article to explain the reasons for this mistaken conviction. I must warn, however, that in stating my opinions I have not the least desire to represent them as absolute and undeniable truths; I do not ask for faith—on the contrary, I want my readers carefully and persistently to test my conclusions.

You will agree with me that the question of whether it is possible to breed cultivated varieties of fruit trees by the natural way of sexual propagation from seed is of too great importance, too much a sore point, for us not to be interested in throwing light upon its erroneous solution. I therefore venture to hope that my work and my humble efforts to elucidate the truth will not be misinterpreted, because I am governed solely by the sincere desire to promote the development of the work I love—horticulture.

In describing the methods I use to produce new varieties of plants from seed, it is far from my wish to represent all this as some new discovery,

as my ill-wishers affirm; I am only trying to elucidate methods of intelligent breeding of new varieties, and not of obtaining them accidentally, as has been the case with us hitherto. And I have not the slightest intention of advertising the varieties I have produced. On the contrary, I impress it upon everyone that new varieties should be acquired circumspectly; they must be first tested in each new locality, and only then, depending upon their suitability, should one proceed to propagate them on a big scale.[1]

When searching for the reason why seedlings of the wild form are produced from seed of cultured varieties, most observers lay the blame exclusively on the influence of atavism. But this view will not stand consistent criticism. Where, indeed, does atavism come in? If the sapling grown from such a seedling were trained in the same environment and in the same conditions in which there accidentally emerged the cultured variety from which the seed was taken for the planting, and it nevertheless deviated structurally, and in the direction of its ancestors—that would be a different matter, and one might accept this explanation. But do not forget that in the case of such plantings no care is ever taken, when training the seedlings, to provide them with those environmental conditions and to bring into operation those factors under the joint action of which they might develop the properties and qualities of cultivated varieties. Yet this is the chief cause of failure.

Furthermore, the so-called wild form of saplings grown from seedlings already in no way represent, in their structure, a deviation towards their forebears, since the structure of each of these seedlings is essentially an absolutely new combination of characters and properties, resulting from the action of new factors which chanced to exercise their influence; and, of course, a very big role is played by cross-pollination, resulting in fertilization with different varieties the pollen of which was accidentally carried by insects to the flowers of the tree that produced the seeds used for sowing.

All this we have to examine and study in order to elucidate and come nearer to a correct solution of the problems interesting us.[2]

True, Nature to us is a closed book, and in order to understand and study one page of it whole centuries of the time and labour of many men are required. The efforts of one man are too inadequate, and the results of the labour of practically his whole life are capable of making a comparatively minute contribution to the treasure store of human knowledge. Nevertheless, in the course of time these contributions, added together, constitute a considerable stock of data for science.

[1] Yet after the appearance of every article of mine on some new variety, I am inundated with demands for trees of the specimen described, when not infrequently I have only the one mother tree of the new variety, from which I can supply cuttings for grafting in only very small quantities.

[2] I beg my readers to show indulgence both for the style of my article and for any omissions that may occur in it. I have absolutely no free time for a more polished exposition, and the omissions are due to abbreviations necessitated by the narrow limits of a magazine article.

It would therefore be downright criminal for us, practical horticulturists, to treat the results of our labour negligently and not endeavour to lay them on the altar of the public benefit.

The methods of breeding new varieties from seed fall into two categories. In the first, the seedlings are grown from the seed simply of select fruit obtained from natural cross-pollination with other varieties unknown to the grower. In the second, the seedlings are grown from seeds taken exclusively from fruits resulting from artificial fertilization, by means of crossing varieties deliberately chosen by the grower. In either case the originator may obtain a new variety with fruits of excellent quality. Nevertheless, the chances of success are greater when using the second method, with the employment of artificial crossing—the percentage of select seedlings is considerably larger, and the qualities of the varieties obtained may be much more valuable. In my work on growing fruits from seed without artificial crossing, I have found that a large proportion of the cultivated varieties of fruit trees I tested displayed a capacity, provided proper nourishment was given to the maternal plant, to produce among their seedlings a certain number that possessed the properties of good cultivated varieties. But the proportion of such seedlings to the total, and their qualities, almost entirely depended upon the providing of those particular conditions which are demanded by each individual variety—both as regards the feeding of the maternal plant, for the better formation of the structure of the seed (preliminarily protecting the flowers of the tree from the influence of the pollen of wild kinsmen), and as regards suitable training of the seedlings themselves, and then of the saplings obtained from them until they attain full maturity. It is sometimes of great help to remove harmful, and to bring to bear useful, influences of outside factors, which often play an active part in the formation of the constitution of various parts of the plants undergoing training. This will be apparent from what I have to say further. As to the so-called influence of atavism, notwithstanding the confirmed opinion of the theoreticians, it is only a very small interference, because in the case of the seedlings of all the different species and varieties of plants without exception, it is irremovable only in the early stages of their development from the seed, and finds expression in the fact that all of them in their youth have an apparent similarity in external appearance with the wild forms of the primeval species. But in the subsequent development of the plants this influence, given proper training, can be easily eliminated: the constitution of the plants is gradually more or less ennobled, depending on the extent the seed contains the elements of culture qualities, and the appearance of their parts changes for the better. This process of change continues in the young plant until it reaches full maturity, after which its characters and properties remain practically unalterable for the rest of its life.

It will therefore be seen that, when selecting the best seedlings according to their external appearance, the horticulturist must bear in mind what has been said about their constitution in their youth, so as not to discard by mistake what are actually good specimens.

I repeat, it must be remembered that, in all its parts and in all the functions performed by its organism, a plant, under the influence of proper care, perfects itself in a way desirable by man only gradually, throughout the whole period until it reaches full maturity.

One must therefore not be disappointed if, for example, the first blossoms of any of the selected seedlings turn out to be incapable of fertilization, or if in the first year of blossoming fruits do not set, or if the first fruits are not large enough or if their taste is not satisfactory. This must not be taken as indicating that the young plant is valueless, because each such defect, provided the plant has all the other virtues, may easily disappear in subsequent years. The grower may detect such a tendency to correction if the fruits show improvement in the second and third year of fruiting, and only if there are no signs of such change in the plant should it finally be discarded.

As to the length of time required for the final formation of the qualities of the fruit of different plants, it should be observed that it varies very considerably, since it depends, firstly, on the individual properties of each plant, and, secondly, on its training.

Sometimes the unsuitable constitution of some particular parts of the plant may act as a retarding factor. I, for example, have had occasion to observe that a seedling which, judging by the external appearance of its overground parts, seems excellent, persistently harbours within itself some defect, or suddenly stops growing, in spite of the best care. In the majority of cases this is due to the unsuitable structure of the plant's root system, which in such cases has to be replaced by one with a structure more conducive to the ends desired by the grower.

Such cases are most often to be observed in seedlings grown from seeds taken from plants grafted on to wild stock, especially when the stock does not belong to the same species as the scion.

This phenomenon is also to be observed in some varieties of plants which for many centuries propagated exclusively from layers or suckers. For example, the root system of most seedlings of the well-known yellow double-flowered Persian rose is very poorly developed, and unless the seedlings are grafted on to strong rootstocks, it is practically impossible to raise a single specimen of this variety of rose and of many of its hybrids; without grafting they are sickly, and in the end perish completely. Similar examples are to be met with in other plants, for instance, pears, apples, plums and cherries.

In general, it should be known that it is not only the characters and properties inherent in the parent plants that are transmitted by heredity to the offspring, but also, in many cases, and moreover in very marked forms, those changes in the hereditary constitution of the plants that are forcibly induced by man, as is so frequently practised by us in our horticultural work. In some seedlings, therefore, it is sometimes easy to observe an exact copy of the grafted part and the wild structure of the roots which one of the seedling's parents possessed. Even the form artificially given to

the maternal parent is copied, as is the case with a pear specimen now growing in my nursery, which had been raised from the seeds of a tree of a foreign variety growing in espalier form.

All varieties of fruit trees and small fruit shrubs that are capable, under given conditions, of transmitting their cultivated qualities in a greater or lesser degree to their offspring may be divided into three groups.

In the first of these groups I class those varieties which produce seedlings with good culture qualities only under conditions that preclude the possibility of their blossoms being cross-pollinated with wild varieties of the same species. Let us take as an example our well-known apple variety, the common Antonovka, which evidently originated in some very recent generations from seeds of wild forest natural varieties of apple as a consequence of which the female reproductive organs, in the process of fertilization, readily react to the pollen of flowers of wild species of apple, these being their nearest kinsmen. Consequently, if there are wild apple trees growing in the vicinity of an Antonovka, only wildings result from planting the seeds of the latter. On the contrary, if it is possible to protect the plants from the undesirable influence of the pollen of wild varieties of the same species, there will be obtained among the seedlings a large number of specimens with culture qualities. A similar phenomenon, but even in greater degree, is to be observed when the blossoms of such plants are artificially fertilized with the pollen of cultivated varieties, and when protective devices, in the shape of tulle bags, are employed as a guard against the pollen of undesirable varieties carried by the wind or by insects. In such cases, of course, the quantity of seeds with good culture qualities will also depend on the individual potency of the variety from trees of which the pollen for fertilization was taken, in the sense of its being able to overcome a similar potency of the pollinated variety. Of this more anon.

In this group, according to my observations, the following varieties may be classed. Of the apples: Antonovka and many of its subvarieties (with the exception of Antonovka-Kamenichka and the 600-gram Antonovka), Anisovka, Ananasnoye Beloye, Ananasnoye Krasnoye, Limonnoye, Miron Rzhevsky, Miron Sakharny, Muskat, Ostryakovskaya Stklyanka, Skrut, Pudovshchina, nearly all the large-fruited Kitaikas and many of the Caucasian semicultivated varieties, including the well-known red-leafed *Malus Niedzwetzkyana*. Of the pears: Tonkovetka, Voshchanka Limonnaya Melkaya. Of the sour cherries: Grushovka, Shubinka, Kent, Griotte Severny and all the hybrids of the wild steppe cherry (*Prunus Chamaecerasus*). As to the plums, not one of the varieties can be classed in this group, since all seedlings of cultivated varieties, if properly cared for, yield fruit quite fit for use, and at most differ from the cultivated varieties only in being of smaller size and having a comparatively slight difference in flavour and yield. I have planted the stones of cultivated plum varieties fairly often, and have never obtained plants the fruits of which were as bad as those sometimes obtained from the seedlings of apples, pears and sour cherries. What has been said of the plum is also true of all cultivated varieties of currant and raspberry:

the seedlings of these plants, given proper care during their growing, produce shrubs with good culture qualities. As to the large-fruited varieties of gooseberry, as well as the grape, they all belong to this group. Of the varieties of strawberry, only the hybrids resulting from direct crossing with the wild forest species belong to this group, the other large-fruited varieties being very little amenable to the influence of pollen of wild forms.

In the second group I class varieties whose capacity to transmit their cultivated qualities to their offspring seems to be not very stable, as a consequence of which it is considerably weakened by certain adverse factors, even when they operate casually and for a very brief period. A very graphic illustration of this is the fact that roots of the wild stock on which fruit-tree varieties of this group are grafted, overcome by their influence the potency of the grafted variety and considerably deviate the constitution of the seed in the direction of the wild form, with the result that the plantings are usually extremely unsatisfactory. But if the originator eliminates this influence, if, for example, he acquires or raises a tree growing on its own roots, its seeds will produce seedlings of good quality. It should be mentioned here that the culture qualities of the seedlings of all cultivated varieties of fruit trees and small-fruit shrubs in general are always considerably enhanced when the seeds are taken from plants that have their own, noble roots, and are not grafted on to wildings.

Very rare exceptions to this are found only when a seedling which itself has good cultivated qualities is used as the stock, or when the stock accidentally happens to be a wilding with a too feeble individual capacity to influence the variety grafted on to it.

Of the apples, in this group may be classed the following varieties: Babushkino, Borovinka, Grushovka, Korichnoye, Rosenapfel, Chornoye Derevo, etc. Of the pears: Tsarskaya,[1] Sapezhanka, etc. Many varieties of plum raised from layers on their own roots yield better seedlings. To this group belong a large number of young apples, pears and plums that have been bred from seed only recently and have not yet had time to develop a stable resistance to outside influences affecting their properties. All young varieties belong to this group only temporarily; later, when the plants of the new varieties mature and their properties become stable, they distribute themselves among all three groups.

In the third and last group I class only those varieties which do not demand the strict observance of special conditions when collecting their seeds, and which produce a good proportion of seedlings with culture qualities. The varieties of this group are more suitable for the initial experiments of the amateur who desires to engage in the growing of new varieties from seed, since the seeds may be taken from select fruit bought on the market. To these varieties belong, of the apples: Skrizhapel and all its strains, and nearly all the strains of Anis. Then come: Repka Purpurovaya Volzhskaya, Vorgulyok, Crimean Chelebi, Green Reinette, etc. Splendid seed-

[1] The Tsarskaya pear was subsequently renamed by I. V. Michurin Rakovka.—*Ed.*

lings are obtained from select round-shaped seeds from the fruits of Aport, Borovinka, Chelebi, Glogerovka, Eiser, and Green Reinette. A good percentage of typical seedlings is also obtained from Kandil and the Sary Sinaps

Of the pears, nearly all the varieties bearing round Bergamotte-like fruits yield seedlings of a good quality. Of the cherries: Vladimirskaya, Izbylyetskaya and Plodorodnaya (a variety which I myself produced). Of plum varieties, I might mention the new variety of Reine Claude that I produced under the name of Reforma, nearly all the seedlings from which have good culture qualities. All the varieties of Reine Claude in general produce a large proportion of excellent seedlings in respect to the flavour of the fruits. The seedlings of currants, many varieties of raspberry, and hybrid large-fruit strawberries, as well as *Fragaria vesca*, well retain the qualities of large size and flavour of the fruit. The Naples currant and Marlboro raspberry especially, if they are given good care, produce seedlings nearly all of which are suitable even for commercial planting.

Such a classification of fruit varieties is, of course, purely arbitrary, and in any case requires thorough testing for each locality and each particular composition of soil, if only for the fact that the properties of many varieties, under the influence of change in soil composition or of climatic conditions—factors which exercise such a powerful influence on the life of plants generally—may in some cases be considerably modified in one or another direction.

To all that has been said, the following observations borrowed from practical experience should be added. In the case of all varieties, the maternal plants from which the fruits are taken must not be too old, too exhausted or diseased. In particular, one should avoid varieties that have been in existence for a long time and are already senile and in a state of degeneration, or, more exactly, are dying out—such as the Saint-Germain pear or our Chornoye Derevo apple. Similarly unreliable are trees which have been grafted on to stock of varieties that do not grow tall, such as the low Siberian apple; and even more unsuitable are trees grafted on to stock of a different species, as for example, pear grafted on quince, hawthorn on mountain ash, cherry on *Prunus Mahaleb L.*, plum on apricot, also, on stock that have for centuries been propagated exclusively by layers and not by seed, and as a consequence has partially lost its capacity to reproduce sexually, from seed, as, for example, the Paradise apple, grown from layers, the blackthorn, etc. Likewise unsuitable are trees grafted on to the head of already full-grown wildings, and, particularly, as it sometimes happens, when several varieties are grafted on the same stock.

All such modifications either artificially introduced by man or of a chance character not infrequently disturb the proper functionings of plant organisms very severely, which, of course, must inevitably have a harmful effect on the quality of the seeds taken from such plants. It is risky to expect good offspring from such individuals. In general, the innovator must pay serious attention to the root system of the maternal plants from which the seeds are

to be taken, and he must remember once and for all that the roots of every plant take an active part in the production of its seeds, precisely in the sense that it affects their formation and lays down the basis for the qualities and properties of the future plants.

Let us now pass on to the second method of obtaining seed, by means of artificial crossing, the chief purpose of which is to create the possibility of combining the qualities and properties of different varieties deliberately chosen by man; from the seeds thus obtained and from the seedlings grown from them, only such are selected as display a combination of qualities most useful to the grower.

We know that the fruit of a large number of foreign western varieties possess far superior qualities to those of our local varieties. But trees of these foreign varieties are unsuitable for cultivation in our parts because they cannot stand the severe climatic conditions. Our local varieties, on the other hand, while they are extraordinarily hardy, suffer from serious shortcomings in respect to the gustatory qualities of their fruits. It is precisely here that one may with great benefit cross our varieties with foreign by means of artificial fertilization, and then, by selection of the seedlings, obtain new varieties possessing both hardiness and improved fruit qualities. Let us take, for example, certain varieties of our wild steppe sour cherry (*Prunus Chamaecerasus*) growing in Samara and the adjacent provinces, which are distinguished by amazingly abundant yields, resistance to frosts as low as 32° R. and extremely aromatic, although, unfortunately, small and very sour, fruits. Yet there are many varieties of sour and sweet cherry of foreign origin which bear large-size fruit of a sweet flavour, but whose trees are tender and lack hardiness in our regions. Here crossing may very usefully be practised in order to obtain hardy new varieties with large and aromatic fruits. Even species of plants of which we have not a single representative may be introduced into cultivation in our parts. In illustration, I would mention the new hardy varieties of sweet cherry and grape I have lately produced, and nowhere yet described, which grow in my orchard without any artificial protection against the winter cold. Yet, not only here in the central part of Russia but even in the South, in the Crimea, cultivated varieties of grape are protected in winter by solid layers of earth, and this solely because the varieties cultivated there were brought in from warmer southern countries and not raised from seed on the spot. Here, in Central Russia, unfortunately, there is not even a single wild variety of grape that could stand our winter frosts in the open, and consequently in this case there would be nothing with which crossing could be performed to increase the hardiness of the delicate foreign varieties. This being the case, what I had to do was first to raise hardy seedlings from seed of a grape that grows wild in Canada (where the temperature likewise falls as low as −32° R.), and then make crosses with cultivated varieties. Thus, in this case too, I was able to solve the problem of obtaining my own hardy grape varieties. It only now remains gradually to improve the qualities of the new varieties by means of successive plantings and selection.

In exactly the same way I am now working on the acclimatization of

peaches. Here, in our region, there is not a single variety of the species *Amygdalus*, to which the peach belongs, that is suitable for crossing with the peach, because our only wild forest almond, also called the dwarf almond [*Amygdalus nana L.*], although it belongs to the same species as the peach, is in constitution far too removed from it, and the crossing does not succeed. After numerous attempts to effect such a crossing, I succeeded in preparing for the role of the hardy parent a hybrid seedling of the Siberian wild almond, which I have named Posrednik [Intermediary].

The beginner in plant crossing should know the following facts, which have been ascertained by practice.

Easiest and most successful are crossings between two varieties belonging to one and the same species, e.g., two varieties of apple, or two varieties of pear, cherry, plum, raspberry, etc. It is far more difficult to cross different species, even if they are closely related—sour cherry with sweet cherry, raspberry with blackberry, etc. In such cases, for greater success I would recommend, on the basis of my experience, to take at least as one of the components of the cross[1] a young plant, grown from seed, at the time of its first blossoming. And, strange as it may appear at first glance, incontestibly greater success is obtained in this way. Further, in some cases, and especially when crossing plants whose flowers have compound pistils (multi-seeded), success in fertilization is greatly assisted by adding to the pollen of the plant of the other species a very small quantity of pollen from a variety closely akin to the maternal plant. Whether the chief factor here is that the stigmas of the compound pistil are more easily excited and activated by contact with the kindred pollen or whether the aroma of this pollen acts as a stimulating factor, I find it hard to say, but by using this method crossings succeed which, when only pollen of the other species is administered, are invariably abortive. I, for example, have managed in this way to secure hybrids of *Amygdalus georgica* and *Prunus pumila L.*; and there have been other cases as well. I have, moreover, observed that a large number of different hybrids, especially at the time of their first flowering, can be far more easily crossed with each other than plants of pure species.

We shall not speak for the present of the crossing of plants belonging to different genera, firstly, because the narrow limits of a magazine article do not permit expatiating at length on such complex and as yet difficult problems. Nevertheless, I cannot refrain from saying that in the future, given the rational interference of man, *this problem will undoubtedly be successfully solved*.

It is a customary belief with us that, in their characters and properties, hybrids represent something intermediate between the parent plants taken for the crossing.

This view is mistaken, because if one analyzes the distinguishing characters and properties of any hybrid it will be found that they almost entirely deviate in the direction of its grandparents, both on the male and the female

[1] Preferably the maternal.

side, representing varying combinations of the properties and characters of these plants.[1] And only by planting seeds from the fruits of the hybrid itself, and with the absolute proviso that these fruits have set from the fertilization of the flowers with their own pollen, does one get seedlings displaying the characters of the immediate parents, naturally, in differing combinations.

It may happen that a hybrid has one or another character of its immediate parents, father or mother, but in such cases it turns out that the grandfather or grandmother on one of the sides also had that character. There are, of course, exceptions, because some characters appear consecutively in individuals of many generations, but this is due to another cause. . . .

It will be seen from what has been said that for an intelligent choice of plants for crossing one must know the qualities of the plants' parents; only then can one act, not at random but with a more or less certain expectation of obtaining desired combinations of properties and characters in the seedlings. If, however, it is impossible to obtain for the crossing varieties whose parents are known, preference should be given to the newest of them, in the production of which wild varieties had no part.

Good results may of course be obtained in such cases too, but one will have to be content with whatever eventuates, it being absolutely impossible to calculate in advance what definite qualities the young hybrid seedlings will possess. However, having waited until the first fruiting of these hybrids, one may plant their seeds and expect to obtain in the seedlings of the second generation certain qualities more or less known in advance. When crossing our cultivated varieties of fruit plants with genuine wild types of the same species, it must be borne in mind that the latter, because of the long time they have existed and their stability, always possess a very strong capacity to transmit their properties and qualities to their progeny, with the result that the characters of the wild parents always predominate in the hybrids of the first generation (Fig.[9]). This of course may not always be advantageous to the originator, especially if he is unwilling or unable to grow from seeds of the first hybrids seedlings of the second and then the third generation, in which the pernicious influence of the wild parent might be considerably weakened, if not entirely destroyed.

Typically wild plants should not be confused with plants which have sprung up in the forests from seeds of cultivated varieties that have happened to be carried there by chance. I have repeatedly encountered the strange opinion in the press, supported moreover by reference to analogous views of well-known foreign horticulturists, that wild plant forms possess a greater capacity for variation.

This opinion, you see, is supposedly substantiated by the fact that some foreign horticulturists, in seeking to produce new varieties of apple and pear, took the seed exclusively from wild trees and found that new varieties are

[1] Consequently, when selecting the varieties for crossing or for the mere collection of seeds, one must give preference to those of them whose immediate parents were cultivated plant varieties and not wild forms.

more quickly obtained from such seed. This is a gross fallacy. It is wrong to believe that all forest apple and pear trees belong to a pure type of the wild species. Who can prove, and how, that these trees did not spring from the seed of cultivated varieties carried into the forest via the stomach of man or bird? True, by repeated plantings and training of seedlings for several generations, one may obtain a cultivated variety even from a genuine forest wilding, but for this immeasurably more time is required than if one sowed the seeds of cultivated varieties.

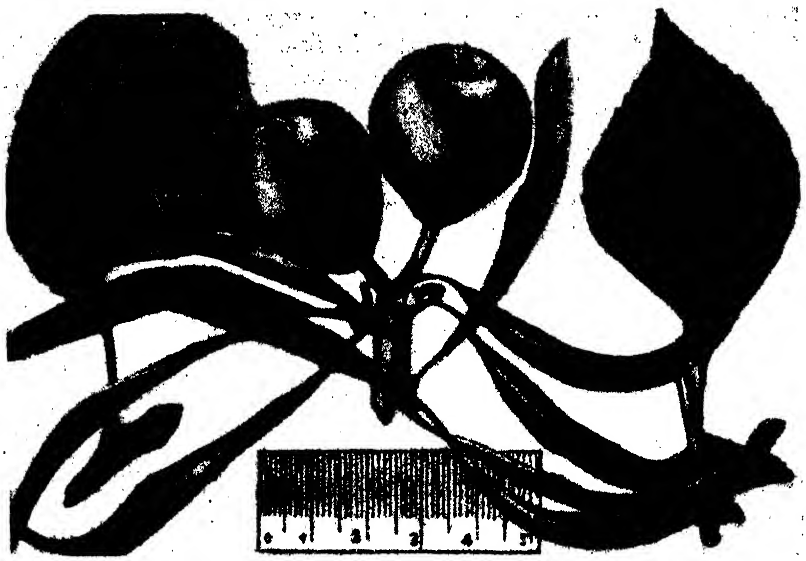


Fig. 9. *Pyrus elaeagnifolia* and its hybrid:
a leaf of a Bessemyanka pear [left]; a twig with two fruits of *Pyrus elaeagnifolia* [centre]; a leaf of the hybrid seedling [right]

The principle that the qualities of the parents must be known need not be essential in all cases, because in some crosses one may calculate on deriving benefit from a combination, not of the varietal but of the specific qualities of the plants, which in a large degree are known to all. If, for example, we desire to lend a delicate plant greater resistance to frost, we may cross it with wild hardy plants of the same species; and we shall not be mistaken in our calculation, because the progenitors of all our genuine wild species of plants also possessed great hardiness, and there will consequently be a large proportion of hardy plants among the hybrid seedlings obtained from them. This is one of the chief ends we, inhabitants of the northern and central zones of Russia, should try to achieve in producing new varieties of fruit plants. As to the question, which of the components of a cross is most capable of transmitting its qualities to the progeny, that depends on the purely individual potency of each of the plants taken for the crossing, irrespective of its sex.

The strongest capacity to transmit their properties is possessed, firstly, by all plants of pure species growing in the wild state, e.g., our wild forest apple, *Pyrus prunifolia,* Siberian crab apple, wild pear, wild steppe sour cherry, blackthorn, damson, wild currant, wild wood raspberry and blackberry, wild strawberry, etc.; and, secondly, by all old cultivated varieties. The weakest capacity to transmit their properties is possessed by young, recently-produced varieties of fruit trees and small-fruit shrubs although of course, in this respect, too, exceptions are to be met with—for example, one comes across new varieties with a far greater capacity of transmission even than wild species, and, on the contrary, one meets with wild species with a weak capacity, but such cases are very rare.

We shall now proceed to describe the process of artificially crossing plants.

Before proceeding to cross one variety with another, precautions must be taken to prevent the blossoms of the maternal plant from being fertilized with their own pollen. That is, one must prevent the flowers that are intended to be fertilized with pollen from another variety from being self-pollinated from their own stamens.

For this purpose, the flowers are first castrated, the operation consisting in carefully removing all the anthers of the chosen flower before they reach full maturity. It is better and more reliable to perform the operation on a flower bud that is about to unfold on the same day, otherwise it will be difficult to avoid self-pollination, because the pollen on some stamens sometimes ripen before the bud opens, and in such cases it is hard to guard against the pollen being shed accidentally.

I consider quite useless in our regions the method of castration practised by the American hybridizer Burbank, who cuts away the entire corolla instead of simply nipping or shaving off the upper parts of the stamens together with the anthers, because the amount of time it saves is negligible, while, on the other hand, together with the unnecessary stamens or anthers the flower loses other parts that are far from unnecessary for successful fertilization; especially if we take into account our drier climate compared with that part of America where Mr. Burbank works, and where the corolla has less significance as a moisture conserver. I, personally, suffered complete failure when I tested this method, the only possible explanation being that the flowers had an insufficient protective covering in the shape of the corolla.

After the castration has been performed, the flower, or the group of flowers, prepared for fertilization should be covered with a bag. For this purpose an inferior kind of muslin or plain soft white gauze is taken and cut into pieces four vershoks or more square; large stitches are then made in the hem with coarse thread. By pulling the ends of the thread you get a round bag, very convenient for protecting the castrated flowers from the pollen of other plants accidentally carried to them by insects or the wind. The castrated flowers are kept protected by the bags for the whole period required for the process of fertilization, and are very useful afterwards for protecting the setting fruit from injury by insects, and they therefore should not be removed until the fruits have fully ripened.

The pollen of the flowers of the variety designated for crossing is gathered and prepared a day or two days before the fertilization is performed, and is applied to the stigmas of the pistils of the castrated flowers only when the pistils have reached full maturity, which can easily be determined by the sticky substance that appears on the surface of the stigmas. It sometimes happens with some flowers that this symptom of stigma maturity is not manifested at all, in which case pollination may be performed without it, although success is doubtful.

It is best to perform the pollination in the morning, between eight and eleven o'clock, because later in the day the substance on the stigmas rapidly evaporates under the action of the sun's heat, and the pollen can no longer attach itself securely and is not infrequently blown off by the wind as a consequence; but the chief thing is that the process of fertilization cannot take place at all in the absence of stigma moisture, because the pollen grain develops its tube only under the action of this substance.

As to the practice of artificially moistening the stigma with various solutions, such as sugar water, it goes without saying that this can only cause harm without doing any good.

As an additional guarantee of success, pollination should be repeated on the following two mornings, and in rainy weather, when the pollen is liable to get washed away by the rain, it is sometimes necessary, in addition to the tulle bags, to protect the flowers with paper caps and to repeat the pollination more than three times. The paper should be of white colour, which least obstructs the light rays necessary for the process of fertilization. It is useful to grease the paper with some oil, but not with mineral oils that easily evaporate, as the vapours may cause harm. The necessary pollen is gathered one or two days beforehand, for which purpose ripe anthers are nipped either with pincers or simply with the bare fingers and are put into a carefully dried glass jar, which should be tied with a cover of fine gauze or tulle as a protection against dust. The pollen must be kept in a place that is shady and, indispensably, dry. In this condition the pollen is easily kept in a state fit for fertilization for a fairly long time. Nevertheless, preference should be given to fresher pollen—one or two days old. Under no circumstances should the pollen jars be covered with any thick material, such as paper, cardboard, etc., because in that case the pollen quickly loses its vitality and becomes unfit for fertilization. At the worst, if it has to be sent long distances, the pollen, after being well dried, should be packed in small quantities in packages of thin paper, and better still, in small packages made of unstarched cotton material.

Before the pollen is used it should be lightly shaken up in the jar, and when it settles on the walls it can then be easily removed with a brush, or a piece of thin cork, or, more simply, directly with a well-washed finger. It is then lightly brought in contact with the stigma of the flower. The flower is again covered with the tulle bag, which in any case should not be removed before three days, although the process of fertilization, if the pollination has been successfully performed, takes from five to twenty minutes, according

to the researches of the botanists. If there is a sufficient stock of bags for other crossings, then, as I have said, it is better not to remove the bags from the plants until the fruits have fully ripened. The crossed flowers should then be marked with a tag showing the number under which it is entered in the journal where the components used in the crossing are recorded. This number is later marked on the packets of seeds gathered from the fruits obtained from this crossing.

The setting fruit, and then the mature fruits, resulting from the artificial fertilization must be protected from all pernicious outside influences that might deviate the structure of the seed in an undesired direction. It should be known that every seed already has latent in it the elements of many of the properties and qualities of the future plant, and every precaution must therefore be taken to ensure their following a direction which answers to man's needs.

Unfortunately, in the present imperfect state of the higher science of horticulture in general, and of the science of producing new varieties of plants in particular, we are not in a position consciously to do much in this field, and have to restrict ourselves perforce merely to certain useful methods, the chief of which, of course, is the elimination of all defects in the nourishment of the maternal plant during the whole period the hybrid fruits are growing on it.

Here it is necessary to stress again that, in general, the plants chosen as the maternal parent must be sound and healthy individuals, otherwise some sickly condition may easily be inherited by the progeny, and the future plants will be of feeble constitution.

The soil around the trunks of the trees from which the seeds are to be collected must be maintained in a friable condition. If until then the soil beneath a tree was overgrown with grass, it may be turned up to a depth of not more than a vershok, because the root system of such trees arranges itself in fine fibres very near to the surface and may easily be damaged by deep digging, after which the tree will suffer in the first summer and not be in a condition to yield normally developed fruit. If, on the contrary, the soil had been kept in a porous state before, it may now be dug to a deeper depth—four or five vershoks—without fear of damaging the roots, which in the case of such trees lie deeper in the ground. After working over the soil it is well to cover it with a layer of rich year-old manure about one vershok thick, and, moreover, if the soil happens to be poor, in the course of the first half of the summer the ground to the whole radius of the crown should be treated with a liquid manure, made of guano that has well fermented for not less than two weeks, mixed with a small dose of mineral manure containing phosphoric acid, which stimulates earlier ripening of the fruit. The quantity and consistency of the liquid dressing should be moderate, since guano manure, containing as it does a large percentage of nitrogenous substances, severely retards the ripening of the fruit, which is particularly undesirable if foreign varieties of fruit trees are used in the cross, because as it is their fruits do not finish ripening until late in the autumn.

In my work I have found the following composition of the liquid manure to be the best: a vedro of dry guano is put into a fifteen-vedro tub of water, and five-ten pounds of superphosphate containing 30-40% of phosphoric acid are added; after this has fermented for two weeks, being stirred daily, one ladle (1/20th-vedro) of the solution is added to every (one-vedro) can of water used for the dressing. I gave full-grown, twenty-five-year-old apple trees about ten vedros of this solution at each watering, plum trees—about five vedros; for small-fruit shrubs two vedros are enough. Generally, it is quite impossible to say exactly what quantity of manure is required, for this entirely depends on the degree of depletion of the soil under the tree. In the case of stone-fruit plants, a surface manuring of powdered slaked lime is useful, but it should not exceed three pounds per adult tree, for superfluous lime has a fairly strong influence in increasing the size of the stones of some varieties, which, of course, adversely affects the quality of the seeds (stones) and of the plants grown from them. Next, with the object of avoiding unnecessary loss of sap in the mother plant, it is necessary, depending on the strength of the plant, to remove sometimes part, sometimes all of its superfluous ordinary, i.e., non-hybrid, fruits. In any case, one should endeavour to expose the hybrid fruits to the maximum possible light and warmth of the sun, since on this depends the amount of sugar substances in the flesh of the fruit; the greater the amount of light and heat, the sweeter the fruit. With the same purpose, besides removing leaves that strongly shade the fruits, the protective bags should not be made of too finely-woven a material, still less of coloured material; it is best to use a white fabric. In general, all fruits grow to much larger size if they do not hang on their stalks, but lie on supports or suspended shelves specially affixed for the purpose.

The alteration in the external appearance and taste qualities of the hybrid fruits obtained from a crossing of two different varieties is in most cases so insignificant as to escape the attention of the observer—the fruits seem to be absolutely identical with the ordinary fruits of the maternal plant; and only later, in the young trees grown from the seeds of the hybrid fruits, does one get fruits with a completely different appearance, which continue to change for several years after the first bearing. But sometimes the contrary happens: I have many times observed marked alteration in the hybrid seeds themselves. For instance, the fruits of the *Rosa rugosa* crossed with *R. bifera*, instead of having the customary bulbous shape, were elongated. The fruits of a Shepalinskaya sour cherry (a less sour variety of the wild steppe cherry), which was fertilized with the pollen of the largest-fruited sour cherry, the well-known Podbelsky, were twice the size of those ordinarily borne by the Shepalinskaya, and their hue, furthermore, was considerably darker. The fruits of an Iron Kanzler peach fertilized with the pollen of the *Amygdalus georgica* hybrid, were one-quarter the normal size. The fruits of *Pyrus Niedzwetzkyana* fertilized with the pollen of the Antonovka turned out to be pale pink instead of the usual red of *P. Niedzwetzkyana*. I might cite other examples.

All that has been said above relates to the external parts of the fruits, or,

rather, to their pericarps; as to the seeds themselves, they nearly always undergo alterations of shape, and the alteration is particularly marked when the cross is made of two varieties with seeds of different shape.

Owing to the varying constitution of the fruit and small-fruit plants of our orchards, the methods of collecting their seeds, of preserving them until they are planted, and of the planting itself differ very much.

The seeds of *apple, pear, quince,* etc., are extracted from the fruits as they ripen. They are dried without washing and are then kept in dry sand until the planting, which in our parts it is best to do at the end of October.

When apple and similar seeds are planted in the ordinary way, they are simply preserved in a dry place without sand. But in this case one must proceed in the way indicated. It is most convenient to plant the hybrid seeds in boxes, prepared in advance for the purpose. The boxes should be one arshin square and a quarter of an arshin high, and made of thin pineboard. Chinks should be left in the bottom boards to allow superfluous water to flow away freely after watering. The bottom is covered with a one-vershok layer of broken brick or tile; this is covered with a thin layer of chunky moss, and then the box is filled to the brink with sandy, friable soil. The latter is evened out by lightly pressing it down with a flat board, and is then slightly moistened from a watering can with a fine rose. About a couple of hours later, when the earth has sufficiently dried, the seeds may be planted; they should be sown to a depth of not more than a quarter of a vershok, and after the surface is again levelled and watered, it is covered with pieces of window glass (to prevent the seeds being injured by mice). In this condition the box remains in the orchard until the spring. If several varieties are planted in one box, the latter should be divided into the necessary number of partitions with strips of glass one vershok wide, pressed to one half of their width into the earth after it has been levelled for the first time. In such cases, each of the divisions is furnished with a zinc label, on which are marked the parents of the crossing of each of the varieties sown, or its number in the record book.

Seeds gathered in the winter from the fruits of late-ripening varieties of apple and pear, as they are gathered, are planted indoors in prepared boxes, and are covered with a layer of snow one vershok thick. When the snow has melted and the surface of the soil has somewhat dried, the boxes are taken out into the orchard and buried in snow. The following spring, after the appearance of the third leaf, the seedlings are pricked out into beds; the seedlings being spaced one-half arshin apart. In the succeeding years they should be retransplanted three times to new soil, gradually increasing the intervals between them to three arshins, at which the young trees are left until they begin to bear fruit.[1]

[1] I recommend such small intervals in the case of apple and pear trees because they are quite sufficient for their growth in the first five years of bearing; then, if the variety should prove to be a good one, it is propagated by grafting in the nursery garden, or the tree itself is transplanted to a different place. There is no sense in planting all the seedlings twelve arshins apart from the very beginning.

The stones of *cherry, plum, apricot, peach,* etc., after gathering, are carefully washed to remove all remnants of flesh and adequately dried, and are then stratified, i. e., are kept in a mixture with sand which has been carefully washed, baked in an oven and then slightly moistened with boiled water. This, besides protecting the stones from spoiling, gradually prepares them for successful germination in the spring. The stones are best protected from the ravages of mice by keeping them in clay pots furnished with clay covers, which are buried in the earth in a dryish part of the orchard, avoiding spots where the seed pots may be flooded by the spring waters.

In the spring the stones should be carefully split, and the seeds released from the shells should be planted directly in the beds at intervals of one-half arshin and to a depth of one-half vershok. The seedlings are transplanted only in the following spring, at intervals of one-two arshins, depending on the vigour of growth of each seedling. The sets of stone-fruit plants grown for the purpose of obtaining new varieties should not be retransplanted at a later age; at any rate, it should be avoided if possible because, firstly, the root system of most of these sets develops well enough without retransplanting, and, secondly, retransplantation of sets of stone-fruit plants at a later age almost invariably acts as a serious handicap to the development of good qualities in the fruits.

The seeds of *raspberry, blackberry, gooseberry, currant, grape, rose,* etc., are gathered as the fruits ripen, are washed to remove the flesh, dried for from three to five days in the warmth of the sun, and are then kept in dry sand that has been baked in the oven and cooled, until the end of the autumn, when they are planted in boxes in a light sandy soil, the seeds being covered with a thin layer of earth of a thickness roughly equal to three times the size of the seeds. The boxes in which these varieties are planted need not be covered with glass, because mice are not attracted by such seeds; nor is there any need to protect the seeds in the winter, because they do not fear frost (provided superfluous moisture and heat have not caused them to sprout in the autumn). In the spring, after the appearance of the third leaf, the seedlings are pricked out into beds. They are spaced from one-fourth to three-fourths of an arshin apart; in the former case, the seedlings must be replanted once again to fresh soil and the spaces between them increased to three-fourths of an arshin; in the latter case, they may be left without replanting until the first bearing, but this procedure is advisable only if the soil is very rich.

Strawberry seeds, after the ripe berries have been gathered, are placed together with the flesh on a piece of coarse linen and put in a sunny place to dry for two or three days. The cloth is then rubbed between the hands over a sheet of paper; the seeds easily separate and are then planted together with the dry and powdered flesh in prepared boxes or, if the quantity of seed is small, in ordinary flower pots. The boxes are made in exactly the same way as described above, only in this case a lighter soil is used, the sand making up only one-half the quantity of earth needed to fill the box, the rest consisting of well-worked sod with the addition of a small proportion of fine peat.

The bottom of the box is covered with a layer of broken brick and moss for good drainage, and the box is then filled with earth, but to a height not more than one vershok from its top. After smoothing the surface and dividing it into partitions with strips of glass, the earth is again smoothed and adequately watered through a fine rose. The small strawberry seeds are then evenly distributed over the surface in each partition, which is furnished with a label showing the variety. Such tiny seeds may only be lightly sprinkled over with a thin layer of crushed peat. Then, without watering, the box is covered with a sheet of glass fitting closely to the upper edges of the box. This averts the necessity for watering, which is very difficult to perform even through the finest rose, the seeds being so small that they are easily washed from their places and their even distribution is disturbed.

Strawberry shoots usually appear the same summer, approximately in the third week after planting the seed; when the third leaf develops, the seedlings are pricked out one-half vershok apart in other boxes containing a more nourishing soil, where they develop into small plants by the middle of the autumn. These second boxes are usually left to winter in the orchard under a layer of dry leaves, the seedlings being planted into the beds in the following spring.

Pricking out of seedlings and replanting of sets is always done, firstly, in order that the root system of the plants may better develop, in respect to a finer ramification of the roots; secondly, because when they are removed to absolutely fresh, undepleted soil, the roots are able to avail themselves of a fuller combination of nutritive substances, which is of great importance for the development of the plants, and which cannot be artificially provided by any additions of manure; and, thirdly, because it makes it possible to give each plant the proper amount of space it requires for its development, depending on its vigour of growth.

The beds for pricking out or transplantation should, wherever possible, be located in places where plants of the species to be planted have not grown for at least ten years. For example, beds for the pricking out or transplanting of raspberries must not be located in a place where only recently raspberry or blackberry grew. On the other hand, cherry, plum, apple or pear may well be grown there; similarly, plum or cherry must not be planted in a spot where any species of stone fruit grew before, e. g., cherry, plum, apricot, bird cherry, etc.

The beds for the pricking out should be well dug to a spade's depth if the plants are small and their roots do not go deep, especially if they are intended to be replanted the following spring. Otherwise, the soil is dug and worked to a greater depth. The surface of the bed must be carefully evened so as to make it exactly horizontal. But the edges of the bed should be banked about one vershok high, otherwise, after rain or sprinkling, the water will run into the furrows and the plants may easily suffer from a shortage of moisture, and moreover the even surface of the bed will be constantly spoiled. The composition of the soil in the beds should as far as possible be such as will provide proper nourishment for the seedlings of the particular species

of plant. Pricking out is best done in the evening, and the next morning the plants should be shaded from the sun's heat with linen or matting or with branches stuck thickly into the ground around the edges of the bed. The seedlings should be set rather deeper in the earth than they were in the planting boxes; very long primary roots should be shortened by pinching, and the other roots should be arranged in the earth evenly spread in all directions. Within about five days the plants will have picked up sufficiently, and all protective devices may then be removed. The beds must be kept clear of weeds all through the summer, and the surface of the soil must be always porous and sufficiently moist.

In our parts, I prefer to transplant one-year as well as older plants only in the spring, because if it is done in the autumn the young plants often suffer so much in the first winter that it is very difficult to cure them afterwards, which of course always has a bad effect on the qualities of a new variety.

It is best to water seedlings and saplings in the evening after the sun has gone down, and preferably in calm weather; because on a sunny or windy day evaporation from the soaked surface of the earth is rapid, and the vapour carries off a considerable part of the soil's heat, as a result of which the movement of sap in the plants is sometimes greatly retarded; and since evaporation of the leaves is also going on at the same time, the plants more or less suffer, and their tips wilt or even wither. Of course, the first watering is given immediately after the planting, irrespective of time or weather, since its purpose is, besides moistening the soil, to help the loosened soil properly settle and fill the cavities between the roots, and generally to press the earth more tightly around the roots, which is what chiefly facilitates the rapid growth of the plant in its new location.

A dressing of liquid manure may be given only when the pricked out or transplanted plants have thoroughly established themselves in the bed and have begun to make new growth, in no case, however, later than the end of July, otherwise the seedlings of some species, having begun to grow rapidly, may not succeed in maturing before the first heavy autumn frosts and will be damaged by them; this even happens to seedlings belonging to the frost-hardiest species.

When transplanting one-, two- or three-year saplings, the ends of the roots must in all cases be shortened with a sharp knife. This is particularly essential in the case of the vertical main roots, which have few branches, in order to induce them to develop finer ramifications. The other roots should be spread out evenly in all directions and arranged as horizontally as possible, also strict care must be taken to prevent the ends of the roots from being bent upwards, for the parts of the roots in this position in most cases die off. Before planting, it is well to soak the roots in yellow clay mixed with water to the consistency of cream. A thicker consistency may be harmful, since it causes the finer roots to stick together and become entangled, and it is hard to straighten them out when planting.

With the exception of pricking out of shoots, in all transplantings and especially of already fairly-grown plants, the latter should not be set deeper

than they were before; on the contrary, bearing in mind that the loose earth under the roots is bound to settle, it is better in many cases to set the plants somewhat higher, so that after the earth has settled they may be in a normal position as regards depth. Furthermore, the nearer the upper, horizontal roots are to the surface of the soil, the more energetically they perform their functions.

The whole process of lifting and transplanting should be performed as quickly as possible. The roots of the lifted plants must be protected from drying in the sun or wind by covering them with damp matting or cloth, or by immediately heeling them into moist earth. All this is necessary because the fine root filaments quickly die off in the dry air, yet the more there are of them, the sooner will the plant take root in its new location, thus shortening its suffering caused by the transplantation; this is particularly important for the training of the seedlings when producing new varieties of fruit plants. If the transplanting is done in early spring or late autumn, when morning frosts occur, the plants may only be lifted when the air has already been warmed by the sun; otherwise, the exposed root fibres of the lifted plants may easily be injured even by the lightest frost. When training seedlings and developing them into fruit bearers, every means at the disposal of man must be employed to incline the constitution of the young organism in the particular direction of cultivation desired. In choosing the means, preference should be given only to those which, while making for the desired results, least disturb the vital processes of the plant. Timely pinching off, for example, is better, in many cases, than later pruning. Further, foreseeing the necessity of transplanting when the plants are older, one should try to get them to develop a more finely ramified root system in advance; this is useful, because the finer the severed roots, the better are they able to withstand the inevitable damage caused by lifting. Plants may be induced to develop fine fibrous roots by planting them in loose friable soil, by frequent transplantation, and trimming the roots in the process, and, lastly, by trimming them without transplantation. This latter operation is done in the spring: one year the earth is dug away from one side of the tree and half the roots exposed and shortened, and the next year the operation is performed on the other half of the roots.

Every seedling must be kept supplied with a certain superfluity of nourishment until its second or third year of bearing; otherwise it may easily happen that the plant, not yet having developed the necessary stability, may, owing to a fortuitous insufficiency of nourishment, deviate in its properties in a direction we do not desire, or its qualities may cease to develop too early. It is very difficult to correct such a deviation afterwards, and sometimes quite impossible. To make this clearer, I shall give a concrete example. A seedling of the Crimean cultivated apple known as Chelebi Alma, crossed with the common *Pyrus prunifolia W.*, in the first year of its growth developed from its root collar two shoots of identical length. Not desiring to miss a good opportunity for experiment, when I transplanted the seedling in the following spring, I divided it in two at the point of junction, planted the

two specimens in different parts of the orchard, and until the first bearing gave one of the saplings increased nourishment, while the other was allowed to grow with only the usual care. The result was that the first tree began to bear two years earlier than the second, and its fruits were twice as large, as may be seen from the two photographs given here of the first fruits of these twin trees. The difference in the size of the fruits continued unaltered subsequently, in spite of the fact that after the second tree began to bear both were given equal care and attention. Fig. 2 was photographed from fruits of the first tree, which had been given extra nourishment, and Fig. 3 from fruits of the second tree [see Figs. 10 and 11]. I have observed an exactly analogous instance of the influence of increased nourishment, resulting from transplantation to fresh soil, in the case of twins from another seedling, but this time at a later age. The two shoots of this seedling grew together until their fifth year in the same conditions, and only then was one of them separated and planted in a new place, while the other remained just as it was in the old place. In this instance, too, the transplanted sapling, in spite of the ordeal of transplantation and considerable reduction of roots consequent thereon, began to bear a year earlier than the tree that had not been transplanted, and its fruits were considerably larger. I attribute the increased size of the fruits entirely to the action of the fresh and undepleted soil. This example indicates that artificial additions of nutritive substances to the soil cannot compare in value to complete change of soil as a result of transplantation; so much so that the great suffering caused to the five-year-old tree by the trimming of its roots did not prevent it from bearing earlier and yielding larger fruits. It should be mentioned that the tree that was not transplanted had a sufficient quantity of roots and was injured far less when the two specimens were separated, and, moreover, that it sat in a well-manured bed.

Fig. 10. Hybrid of Chelebi Alma × *Pyrus prunifolia* (one-half natural size)

It should be borne in mind that in the process of adaptation of a young plant to the environment in which it lives and develops, the constitution of the various parts of its organism always change in one way or another. Some of these changes persist all through the life of the plant, whereas others,

when the factors inducing them have been removed, gradually disappear as time goes on. Mark the most interesting fact of this kind—the adaptation of a plant even to such conditions of life forcibly imposed upon it by man as the grafting on it of a part cut from another plant. Every grower knows that a far smaller proportion of successful grafts are obtained when budding a new variety that has never yet been propagated by grafting, than when budding an old variety that has long been propagated in this way. This is particularly marked in the case of stone-fruit plants.

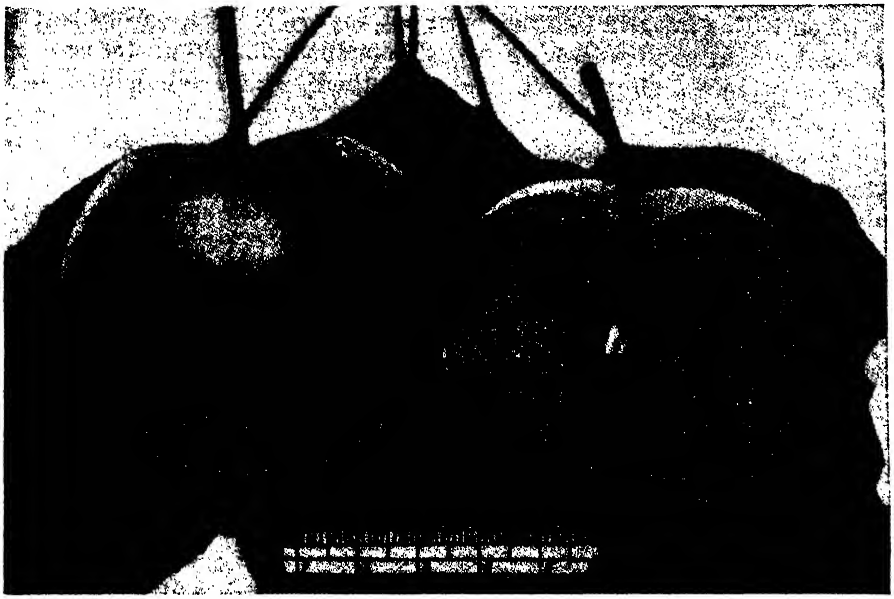


Fig. 11. Hybrid of Chelebi Alma × *Pyrus prunifolia*

Exactly the same thing happens when new plants are propagated by layers and cuttings. Later, of course, when cuttings for grafting are taken from the first grafted trees of the new variety, things go much more successfully, and as this method of propagation is continued abortive results cease.

Another example of alteration in properties of plants is the gradual reduction of the vegetation period in certain hybrid seedlings when their growth is year after year artificially reduced at the end of summer by pinching off the tips of the shoots. It should be remarked that this device, when applied to older plants, or to young grafts, but of old varieties, is absolutely ineffectual, even if repeated for several years in succession. A proof of this may be seen in foreign plants that have been growing for decades in our parts, whose leaves remain quite green and their shoots immature right up to the winter; the tips of their shoots are cut off every year, yet the vegetation period of many of them does not change in the least.

I would cite as a third example the change in the thickness of the shoots of a seedling undergoing training, attained by systematically pinching off superfluous shoots that are on the point of developing and reducing their number to the absolute minimum. Lastly, big changes are induced in the seedlings of the apple and pear, for example, by the use of a special mechanical contrivance that artificially alters the angle of inclination of the wood cells of each individual sapling, causing knottiness (contortion), which then continues to remain in this way without alteration all the rest of its life. As a result, an entirely different variety is obtained from what the seedlings would have given if this method had not been employed. This can easily be verified on seedlings that chance to have two shoots springing from the root collar, by applying the twisting device to one of them, and leaving the other untouched as a control.

Of course, the methods of forcible alteration which I have illustrated by examples do not succeed equally well on all young plants; one encounters plants whose properties cannot be altered. One also encounters some in which the above-mentioned changes have already been transmitted by heredity; for instance, some of them can be propagated well at once both by grafting or planting cuttings, and by layering. Nevertheless, such instances of hereditary transmission of very marked changes induced by man in the constitution of a plant organism are not met with very often.

In training trees from seedlings, on no account should one artificially give them a cordon or palmetto shape or the like, because if such a violence is done to the free growth of trees raised from seed, they remain sterile for a long time. This has been proved by numerous experiments, and was pointed out already in the last century by our well-known Russian originator of new varieties of fruit plants, Mr. Regel. This once more proves that many methods of so-called form cultivation often cause fairly considerable harm to the normal development of plants.

According to my experiments, the best shape for trees of a new variety grown from seed is that in which every tree of the new variety itself strives to grow: in apples, low-stemmed and bushy; in pears, high pyramidical; in cherries and plums, shrubby—depending upon the genus and species of the plant. If these rules are observed, the trees will begin to bear earlier, and the trees themselves will have a more healthy appearance. The only duty of the horticulturist here is to take care to remove in good time, when they first begin to develop, such buds or young shoots as might subsequently prove superfluous, and result in the development of a too dense crown, or such as might later cause harm by rubbing against other branches; if, owing to inadvertance, such branches have been allowed to grow, then, of course, pruning has to be resorted to.

I have already in the first pages of this article dwelt on the shortcomings of the assortment of fruit plants grown in our parts, and in producing new varieties of these plants we shall have no difficulty in determining, or, rather, outlining, the ends we must strive to attain. For instance, it must be regarded as one of the chief and principal aims of the originator to achieve a selection

of fruit and small-fruit varieties that are fully resistant to the climatic handicaps of our region. Then, varieties must be selected that are distinguished by maximum productivity; the latter is determined, firstly, by largeness of crop and annual bearing, secondly, by the flavour and appearance of the fruits of each variety, thirdly, by the capacity of the fruits to keep for a fairly long time without spoiling and to be transported long distances without the need for very laborious or costly packing.

It should not be considered impossible to produce a new variety possessing some special quality, even if all the existing old varieties of the given species of plant lack the desired quality. For example, the fruits of all our present varieties of plums cannot be kept in a fresh state for, say, more than a month; yet this did not prevent me from obtaining from seed a new variety, that I described under the name of Tyorn Sladky, in *Vestnik Sadovodstva i Ogorodnichestva*, 1907, No. 6, the fruits of which keep excellently without spoiling for more than three months. Such a property in a new variety is very valuable, because in the late autumn any kind of plum in the fresh state will fetch a high price in the market. It is similarly of great advantage to produce varieties of fruit plants capable of yielding the largest proportion of seedlings with good culture qualities. I am not referring to the production of constant fruit plants in the full meaning of the word, that is, such that would transmit to their progeny all their properties and qualities without any deviation. This is as yet very rarely encountered in Nature, and it is difficult to say with confidence whether man in the near future will be able to subject orchard plants to his will as he does cereals today, because such constancy can be achieved only when plants have been propagated for many years in the natural, sexual way—from seed—followed first by a strict selection of the best and most typical progenitors, and by the training of several successive generations.

Consequently, the obtaining of such constant plants in all varieties, requires a considerable length of time. I am therefore not dealing with such varieties, but only with those that in general produce seedlings possessing good culture qualities, although they may belong to different cultivated varieties. For example, I have produced from seed a new variety of plum which I have named Reine Claude Reforma (described in *Vestnik Sadovodstva i Ogorodnichestva*, No. 10, 1908). This very valuable variety, in respect to the excellent qualities of its fruits, yields seedlings, 80% of which possess good culture qualities characteristic of the different varieties of Reine Claudes. Precisely such types of fruit plants may serve as the most reliable basis for the rapid development of fruit growing by methods easily available to all, and on a scale which under the old methods of fruit growing could never be dreamed of.

Further, one must undoubtedly count among the desirable qualities of new varieties the capacity to produce seedlings that begin to bear as early as possible. Varieties with this property should be of great value, as everyone will easily understand. The sooner the seedlings of any given variety are capable of bearing fruit, the more profitable is the cultivation of that variety

to the grower—so much so at times as to warrant him being less strict in selection even as regards the flavour and appearance of the fruits. What I want to say is that, in laying out orchards, one may in some cases give preference to varieties that begin to bear early, even somewhat to the detriment of the taste qualities of the orchard's produce.

Let us take an example. When laying out cherry orchards for commercial growing, many have no hesitation in giving preference to the well-known Lyubskaya variety, which bears very sour fruit, although in the same locality other varieties with sweet and larger fruit might grow quite well; and this only because the Lyubskaya cherry usually begins to bear already at the age of two, and the annual yield of this variety is very big, whereas many varieties with sweet and large fruit may be expected to bear not before five, and sometimes even eight years, and during these five-eight years additional money is required for care of the orchard, and that money is not always available.

In the case of small-fruit shrubs—raspberry, blackberry, currant and gooseberry—capacity of the seedlings to begin bearing at an earlier age is not of much importance, since the majority of the seedlings from such plants usually begin to bear already in the third year; but seedlings of apple, pear, quince, sour cherry, plum and certain varieties of grape for the most part do not begin to bear fruit for a long time—sometimes more than fifteen years. This shortcoming may be eliminated, in the first place, by choosing as parents species and varieties which produce seedlings that begin to bear early.

Of the apples, for example, the whole species *Malus prunifolia Borkh.*, with many of its varieties, is distinguished by a capacity for bearing at a very early age, which it transmits to the majority of its hybrids. Of the pears, this property is possessed by one of the varieties of the Ussurian pear. Of the sour cherries, our wild steppe cherry and most of its natural varieties and hybrids begin to bear twice as early as others. Of the plums, the damson, the sloe and the Reine Claudes are distinguished by this quality. Of the grapes, the most early bearing are *Vitis riparia Michx.* and the Central Asiatic varieties of *Vitis vinifera L.*

Secondly, this may also be attained by selecting from the seedlings of different varieties individuals that are distinguished by exceptionally early bearing. This is not difficult to do, especially as such qualities are very often met with in seedlings even of our old varieties of fruit trees. Of the apples, for example, I might point to the well-known varieties Anis, Skrizhapel Purpurovy and Vorgulyok, among seedlings of which I have found six-year-old specimens that were already bearing fruit. This tendency must be developed to the utmost and fixed by means of selection and repeated plantings for several generations. As for artificially accelerating the onset of the first bearing in all fruit trees grown from seed, one very effective method is to graft onto branches of the crown of young trees buds taken from other trees, even of old varieties, but distinguished by heavy yields, with the proviso.

however, that the tree from which the buds are taken is of mature age, that is, already bearing. As a result of such grafting, *fruit buds appear on the branches of the seed tree even earlier than on the shoots developing from the grafted buds of the other variety*. Naturally, after the seed tree begins to bear, the grafted parts of the other variety are pruned. The impression one gets is that the sapling, which has not as yet reached its bearing age, acquires, from the buds of the old already fruiting variety grafted onto it, the property or capacity for building in its organism fruit-bearing parts much earlier than it naturally would.

I must warn that all methods formerly applied in the production of new varieties to force bearing in fruit plants for the most part fail to achieve their purpose, and, moreover, often have a very harmful effect on the quality of the fruits of the new variety. Never under any circumstances should one practice the method recommended by many growers of accelerating the first bearing of a young variety by grafting it onto the crown of a mature and fruiting wilding or even onto a grafted cultivated variety; this may be done not before the third-fifth year of its independent bearing otherwise the constitution of the young variety, not yet having developed sufficient resistance to alteration, easily succumbs to the influence of the roots of the adult wilding or cultivated variety—it makes no difference which, since all trees of cultivated varieties in our orchards are grafted on to wild roots. Although in such cases the new variety does sometimes begin to bear earlier, the constitution of the plant, in many of its parts, deviates toward the wild species, and the fruits lose many of their best qualities. In a word, one gets a new vegetative hybrid, possessing a mixture of the qualities of the new seed variety and the qualities and properties of the wilding on the roots of which this new seed variety was grafted.

As a graphic and convincing demonstration of such alteration, I give here photographs taken from a Bellefleur apple tree and a hybrid obtained by crossing it with the Antonovka. In Fig. 2 [see Fig. 12], the leaf on the left, *Aa*, is from a genuine Bellefleur, the leaf *Bb* in the middle is from a select high-grade seedling of a hybrid between Bellefleur and Antonovka, while the leaf on the right, *C*, is from a seedling of this same hybrid, but one that had been grafted on to the crown of an adult Aport. Remark how well-formed, in respect to culture characters, is the leaf from the select hybrid seedling: it promises to compare in characters with its parent, the Bellefleur, and even to surpass it.[1] Now examine the leaf of the same hybrid, that had been grafted on to the crown of an adult Aport tree. How it has changed! In all its features it resembles the leaf of a most ordinary wild apple.

The leaf blade has been reduced to one-third of its thickness, it has become considerably paler in hue, its veins hardly stand out, the crinkliness of the surface has almost disappeared, the serrations of the edges have grown

[1] It has probably been influenced, not by the Bellefleur itself but by one of the latter's progenitors.

sharper, and the petiole has lost almost half its thickness. A similar alteration is distinctly observable in all the other parts of the plant, including its fruits. In some cases, it may not be without interest to the originator to graft a new, as yet not bearing variety grown from seed on to the crown of an adult tree of a cultivated variety, but one that has not been grafted on a wild stock and has its own roots. What is of interest here is not the acceleration of the bearing period of the grafted variety grown from seed,

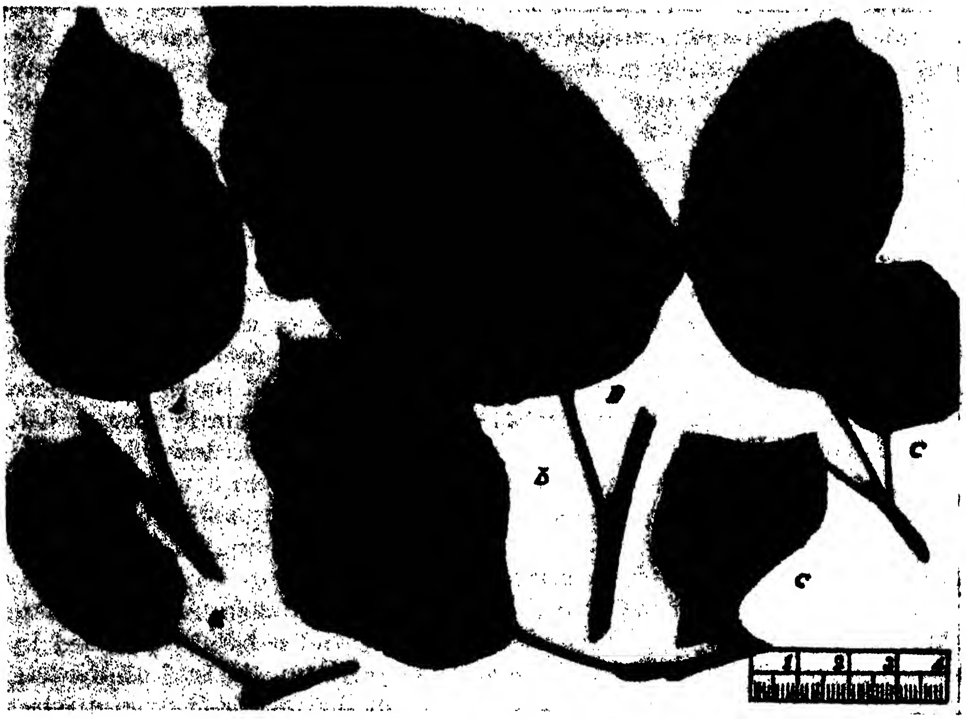


Fig. 12. Bellefleur and its hybrid

but the obtaining of a new vegetative hybrid, and moreover, without any great risk of its deviating towards the uncultivated state, since the influence of wild roots is eliminated in this combination.

Even if anyone should have happened to obtain new seed varieties of good quality, in spite of the fact that they were grafted on to the crown of adult trees, this would still not serve as a refutation of my views. Such varieties would evidently have had even better qualities had they not been grafted at a young age on to the crown of an adult tree with wild roots.

In localities with sharp variations of temperature in spring, where the bark of trees often suffer from the sun, when breeding new varieties of fruit plants, it is best wherever possible in making the selections to give preference to varieties, the young trees of which are less liable to sunburn. That such

varieties exist there can be no doubt, as I myself have met with varieties of apple trees which never suffer from burns. Relatively later opening of the flower buds in the spring and resistance of the flowers to spring morning frosts are also valuable qualities in a new variety, to which attention should be given in selection.

When selecting, the fact should not be lost sight of that some plants of new varieties, although they may bear abundantly in the nursery, suffer from serious defects in the structure of the sex organs. The big yield of these plants is due to the fact that they stand in close proximity to other varieties of one and the same species; if such a plant is isolated and planted by itself, it often remains completely barren.

Selection of seedlings of fruit and small-fruit plants in their early years of training. In order not to spend unnecessary labour on tending and training all the seedlings, of which no more than a few ever prove to have outstanding qualities, it is necessary in the very first years of training to pick out the young plants which display the best external characters and to destroy all the rest. Only in the case of plants that begin to bear at an early age, e. g., strawberry, raspberry, blackberry, currant, etc., which bear fruit already in their second or third year, or of such the available number of seedlings of which is small as it is, is it reasonable to train all the plants without exception until they bear their first fruit, and then, after the quality of their fruits has been finally assessed, to destroy the bad plants and leave the good ones for propagation.

In the case of plants of species that require long years of training until they begin to bear—e. g., apple, pear, quince, plum, cherry and apricot, which begin to produce fruit at the age of ten to fifteen years and even later—selection at a young age, beginning with the first replanting of the yearlings, is absolutely essential, especially if a large number of seedlings of each variety is available.

Such selection has to be based solely on the external appearance of the young plants or of its individual parts: thickness of shoots; fluffiness of their tips; space between the buds, their shape and size; size, thickness and pubescence of the leaf blades and leaf stalks; shape of the leaf dentations; shape and size of the stipules and, lastly, the general external habit of the plant.

Further, the degree of resistance of a plant to the various climatic handicaps of its birthplace—frost, drought, heat, etc.—begins to be manifested at its earliest age. All this is taken into account when making the selection, but that indefeasible law of life of all living organisms must not be forgotten by virtue of which every plant, with all its parts, does not reach perfection at once, in the first year of its existence, but only gradually over the course of several years, passing through all its stages of alteration from the wild state to the cultivated. Consequently, when selecting from young plants, especially yearlings, attention must be paid to relatively the minutest deviations and characters, at times only in some of the plant's parts, that incline towards the cultivated state; and, generally, assessment of the number of

good features should not be very strict or very negligent, because the signs of certain alterations in the young plant may be so inconspicuous as to be easily missed, and what are actually very valuable individuals may be discarded. Unfortunately, it is almost impossible to give a faithful description of the characters of all good varieties of plants in their young stage, since they are very diverse and differ for practically each separate individual, and some of them simply baffle description; one cannot find words to describe their peculiarities in a way understandable to others. One learns with experience to distinguish them clearly, but one can convey them to others only on the spot, standing before the plant itself.

It goes without saying that even those few principal characteristics that are easily noticeable and conveyable even to inexperienced persons, differ not only with each species of fruit plant, but even in their separate varieties. I shall therefore endeavour, as far as possible, to enumerate these characteristics for each species and for a few varieties separately. In doing so, I shall, on the basis of my thirty-three years' observations, give the age at which the plant first begins to bear: the first figure will indicate the earliest age of bearing observed, the second will be the average for the greatest part of the total number of seedlings of the given species, the third will indicate the latest age at which the plants began bearing. I shall then mention the most suitable soils for the training of seedlings of each species, as well as soils that produce undesirable results in the culture. Further, I shall enumerate chosen varieties of plants which I have found in my work to be most suitable for the collection of seeds, as well as for the role of parents in hybridization.

Naturally, my information cannot be expected to be as full as might be desired in this instance, if only for the fact that one man, no matter how devoted he may be to the work, nor how energetic, cannot experiment or make observations more than his personal strength and means permit.

Good characteristics in apple seedlings are the following: a more luxuriant growth of the plant as compared with the seedlings of the same variety growing next to it in the same bed; relatively thick shoots and somewhat ribbed; the surface of the bark at the tip of the shoots downy; the buds close together and larger; the bud cushions well rounded, and the nodes below the buds standing out prominently and vertically; the leaf blades large and, particularly, thick, dull and wrinkled on the upper surface and hoary on the under surface; the veins on the underside of the leaf clear-cut and protruding, and the serrations on the edges of the leaves small, blunt and rounded; the leaf stalk relatively short, but thick and downy; the stipules large, etc. For better illustration of this outline of good characteristics, I give here a photograph (reduced) of a leaf of a true Anis, a leaf of an Anis seedling selected for its high-grade characters, and a leaf of another Anis seedling but of inferior quality [see Fig. 13]. I believe that this illustration will be of considerable help to the beginner in the study of signs of a good variety in seedlings. I would ask you to note that it may be infallibly judged from the characters of the middle leaf in the illustration that this seedling will

produce a new Anis variety, with far better qualities than even the parent itself—a true old Anis variety (as actually turned out to be the case). The third leaf, on the righthand side of the illustration, also promises to be a cultivated variety, but its qualities will, in any case, be inferior to those of the old Anis variety. Apple trees bred from seed begin to bear fruit at different periods. There have been cases of seedlings which began to bear from their fourth year. This occurs, in particular, when one of the ancestors of the new variety belonged to the natural variety of the apple Kitaika [*Malus prunifolia*] or of other species of apples of Eastern or Southeastern origin, whose fruits ripen early in the summer. On the average, the greater propor-

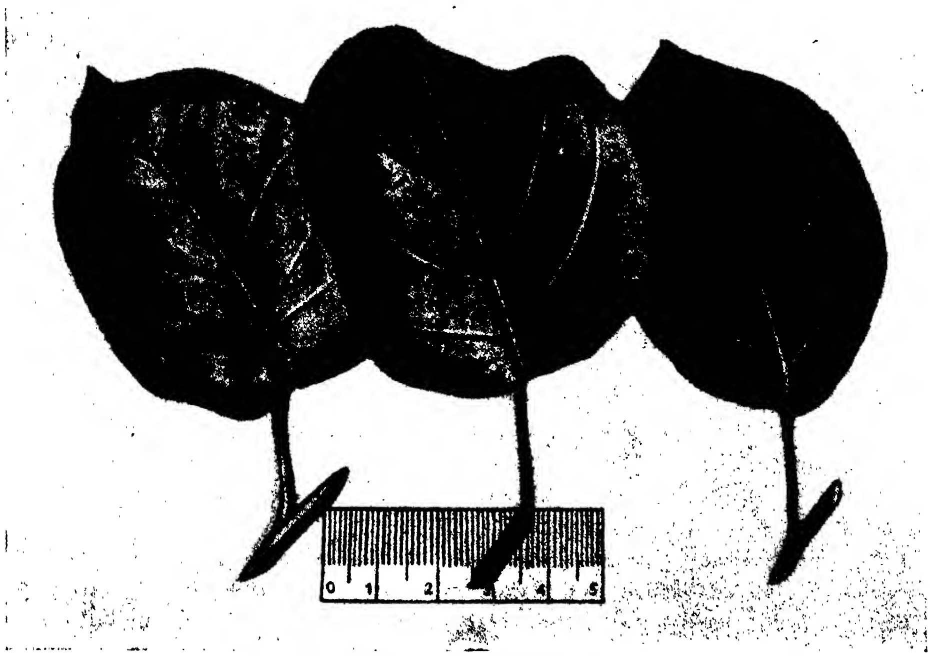


Fig. 13. Selection on basis of leaf characters:
left—a leaf of a true Anis; centre—a leaf of an Anis selected for its high quality;
right—a leaf of an Anis seedling, poor quality

tion of apple seedlings, given proper care, usually begin to bear somewhere between their eighth or twelfth year. Some varieties, especially those in whose production winter varieties of Reinettes of Western origin had a part, not infrequently begin to bear not earlier than their twentieth year, or later.

As regards soil, a deep, porous black soil, rich in humus, with a clayey, sufficiently humid subsoil, is most suitable for the growing of apple seedlings. On dry sandy, and especially saline, soils, the fruits of the new varieties turn out to have an insipid taste, are of small size, and are little suitable for keeping in a fresh state. Cold low-lying localities produce small, sourish

fruits, and the young plants stubbornly incline towards the wild state, even though they possessed good culture qualities before they were transplanted to these localities. It is of considerable help in growing new varieties of apples to introduce into the soil a liquid manure made of guano mixed with nitrogenous or other mineral fertilizer, such as Chile saltpetre or Thomas slag. In particular, such a manure produces astonishing results if the plant beds are given electrical treatment, provided the tension of the current does not exceed two volts. According to my observations, a higher tension does more harm than good.

The varieties of our cultivated apples most suitable for the collection of seeds with the aim of breeding new varieties and for hybridization with superior foreign varieties, I find to be the following: Skrizhapel and all its variations, Anis and its varieties, Vorgulyok, Borovinka, Repka Volzhskaya, Eiser, Korichnoye, etc. Of the semicultivated—*Pyrus prunifolia* and its natural varieties—the Volzhsky Reinettes. Of the foreign and of our southern varieties: Bellefleur, Glogerovka, Sinap Litovsky (or Montvillovka), Ribston Pippin, Cellini, Virginskaya Rozovka, Crimean Chelebi. Then, of the tenderest: White Winter Calville; Baumann's Reinette, Coulon-Reinette, Cassel's Reinette, Reinette Canada, Golden Winter Pearmain, Ananas-Reinette, Sary Sinap, Kandil Sinap, etc. Of the Caucasian semicultivated varieties, the variety known by the name of the Niedzwetzkyana (*Malus Niedzwetzkyana*) is very interesting for hybridization; its bark, leaves, blossoms and fruit are of a red hue, but it is very unhardy in our parts. I have at present in my nursery some fourteen of its hybrids with our Antonovka. In Fig. 6 [4] I give a photograph of a fruit of a splendid hybrid obtained by crossing the well-known Crimean variety, Kandil Sinap, with *Pyrus prunifolia*. In respect to flavour the fruits of this variety are far superior to those of the Kandil Sinap.

In pear seedlings, luxuriant growth of the whole plant and relatively thick shoots are likewise good characteristics, as are larger size and more elongated form of the leaf blade, a darker green colour of its upper surface, elegant and very fine network of the veins on the underside of the leaf and a thin lustreless bloom on the whole surface of the underside. In general, elegance of the vein networks on the under surface of the leaf in pears is a sure sign of culture qualities in the seedlings, as are also smallness and bluntness of the dentation of the leaf, or its complete absence. Downiness of the tips of the shoots and of the leaves may be observed only on young shoots which have not matured; towards the end of the summer this downiness disappears, as does the reddish hue of the young leaves. If the buds are closely compressed to the shoots and are large and round, this is also a good symptom. Next, *crookedness* of the shoots, long stipules and complete absence of thorns, which tend instead to turn into short blunt twigs, are indicative of the presence of cultivated qualities in the seedling. (But I have obtained new varieties of pear with fruits of excellent quality, yet the saplings of these varieties had a mass of long and sharp thorns even when the trees had reached bearing age. This, in particular, is a distinguishing

feature of a variety obtained by hybridizing the Sapezhanka with the Saint-Germain.) It may also be taken as a good sign if the leaf is trough-shaped and its edges crimped. The first fruits of pear trees, as of all species of plants generally, are always much smaller; their size and taste qualities develop only gradually in the course of several years of bearing. I have had occasion to observe very big alterations: for instance, the first fruits of several new varieties were no more than five zolotniks in weight, but from five to eight years later these same varieties produced fruits weighing twenty-five to fifty zolotniks, i.e., nearly ten times as much, and, moreover, their taste had improved beyond recognition.

Fig. 14. Russkaya Moldavka. Hybrid of Moldavskaya Krasnaya × Tsarskaya

Generally, pear trees grown from seed begin to bear later than apple trees. I have never seen in my nursery seed pear trees bearing fruit before they were ten years old. The average age at which the greater proportion of seed pear trees begin to bear must be taken as twenty to twenty-five, but I have several trees which, although more than thirty years old, are still not bearing. Much here, I believe, depends on the dry rather silty soil; if the pear trees had a more suitable soil, they would very likely have begun to bear fruit earlier. But in general I have remarked that pear trees begin to *bear* only when some diseased condition appears in their organism. Therefore, in the case of all seed pear trees, it is necessary to employ the method I have described above of artificially forcing the trees to begin bearing by grafting onto their branches buds from another, already bearing, variety. The most suitable time to apply this method, I find, is when the trees are between eight and ten years old. I give a photograph of two fruits of a young tree of a new variety of pear that I bred recently and have as yet nowhere described, which I have named Russkaya Moldav-

ka—a hybrid obtained from the crossing of Malikovka (or Moldavskaya Krasnaya) with our old hardy variety of pear, Tsarskaya [see Fig. 14].

As regards the composition of soil most suitable for the training of pear seedlings with the object of obtaining new varieties, pears in this respect are in general far more exacting than apples. In our parts new varieties with good fruit qualities are obtained exclusively on porous clayey, well-manured soils, and sufficient moisture is essential. In ordinary dry black or sandy black soils, the fruits turn out to be of far inferior quality. It is particularly difficult under such conditions to obtain pear varieties with fruits capable of keeping in the fresh state for comparatively long periods after harvesting, and, moreover, the flesh of the fruits has not that pleasant oily quality that distinguishes all Beurrés of foreign origin. On dry sandy soils insipid sweetish fruits are usually obtained, with a dry flesh of mealy consistency; in low-lying cold and excessively humid places one gets almost exclusively sour fruits with a hard, astringent flesh. The beds for the training of pear seedlings should therefore wherever possible be located in warmer, rather elevated sites with a humid clayey subsoil. This ground must be dug deeply, to no less than three-quarters of an arshin; if the soil is deficient in clay, the latter must be added in suitable quantity mixed with fully decomposed, not very strawy manure, with the admixture of a small proportion of sand, which must be coarse (fine sand only causes harm by making the soil too compact). It is also useful to add crushed peat; peat is particularly necessary on the surface of the beds, because a thin layer of it retains moisture evenly in the upper layers of the soil, prevents the formation of a dry and compact crust, and facilitates greater absorption of solar heat. Here, too, electrical treatment is very useful.

Of our cultivated pears, I consider most suitable for crossing with foreign tender varieties, on account of their outstanding hardiness, firstly, Tsarskaya, then Tonkovetka, and of the new varieties which I produced, the Severnaya Margarita and Kozlovskaya Rannaya, which are somewhat still hardier. Of the pear varieties with fruits of superior flavour and suitable for cultivation in the Tambov Province, the following are good: Malgorzhatka, Medvedevka, Sapezhanka; of the new ones which I bred: Beurré Kozlovskaya, Bergamotte Novik, Moldavka, Andreyev Bergamotte, Zhermenovskaya and Belaya Osennaya. Of the rather tender varieties, but nevertheless suitable for cultivation in our regions in relatively protected orchards and on warm dry soils: Sakharnaya, Moldavskaya Krasnaya (or Malikovka), Beurré Romen (or Panna), Ilyinka (or Kabak-Armud), Garnich-Garnitsky Beurré, Myasoyedovka, etc. Good also is a variety I have bred by crossing the Tsarskaya pear with Malgorzhatka, which I have named Severnaya Margarita; although its fruits are small, they are usually of a sweet taste, and the variety is distinguished by the very early maturing both of its fruit and its wood. Its leaves already turn yellow at the end of August, soon after the small but very sweet fruits have ripened; the variety is of an exceptionally high frost-hardiness, which makes it eminently suitable both for cultivation in more northern localities, and for hybridization with delicate

foreign varieties with a view to imparting to the latter greater resistance to cold.

The *quince* is practically never seen cultivated in the open in the regions of Central Russia; natural varieties of quince have only been used in our parts as stock for low-growing trained pear trees, and even then, owing to the weak resistance of the roots of this plant to our frosts, it was absolutely necessary to protect them in winter by banking them up with earth. The overground parts of the trees of quince varieties of foreign origin froze in our regions nearly every year to the snow line.

Furthermore, all the varieties of this plant had the very substantial defect that, by their nature, they demanded for their cultivation soil containing abundant moisture, which, it goes without saying, could be supplied in the orchards of our dry continental climate only artificially, by constant and generous watering; naturally humid sites in our orchards are absolutely unsuitable, because of the fact alone that they are all too cold for the cultivation of such a tender plant as the quince. For more than fifteen years I employed every possible method to get this plant to grow in my orchard, but without avail; all the quince varieties without exception failed to withstand our frosts, and perished. Only in 1903 did I manage to secure seeds of a hardy quince variety that had been bred on a dry sandy soil by one of the colonists of the Saratov Province. Of the seedlings grown from this seed, more than a thousand individuals proved to be sufficiently hardy and capable of growing in dry places, and last summer many of them bore their first, and fairly large, fruits. I still consider it premature to publish a description of these new varieties, because in the first three to five years of bearing their fruits will probably alter very markedly both in size and in taste qualities, and only then will it be appropriate to give a detailed description of them. Some three years ago I learned that there was a hardy, large-fruited variety of quince growing in Samara,[1] in the orchard of Mr. Reshetnikov; two-year seedlings of this variety growing in my orchard have likewise proved to be very hardy, and, I believe, many will prove to be excellent plants as regards fruit qualities and resistance both to frosts and to dryness of location. Accordingly, there is now no longer any doubt that the quince may be cultivated in the orchards of Central Russia without any artificial protection against the winter. Moreover, the new variety of quince will be far more suitable not only in our, but also in more southern, parts as a stock for dwarf pear trees that is hardy and does not demand a great amount of moisture in the soil.

Of the best foreign varieties suitable for hybridization with the hardy varieties we have now, I would mention the following: Mammoth, Bourgeaut and Champion, and, of the newer varieties—Bereczki, the Giant of Leskovats, Deman, Chinese and others. I must warn that the seedlings have to be trained on a dry soil, otherwise the above-mentioned property of the new hardy varieties, namely, their capacity to reconcile themselves to a dry

[1] Now Kuibyshev.—*Ed.*

soil may weaken since it is not yet fixed and stable. After three to five successive generations of seedlings have been grown, this precaution will be unnecessary.

In selecting plum seedlings, it must be borne in mind that the varieties of this species fall into three sharply defined groups, possessing different characters and demanding different compositions of soil for their training. In the first group we shall examine the plums with oval, elongated fruits known as Vengerkas. Good symptoms in the seedlings of this group of plums are: exceptionally thick shoots; large, closely-spaced buds with broad bases; very prominent and fleshy bud cushions; leaf blades and stalks of elongated form and of large size and thickness; sharply protruding veins on the underside of the leaf, and downiness of the stalk and principal central vein of the leaf; broadish and blunt oval-shaped dentation on the edges of the leaf blade, with prominent nipplelike protuberances at the junction of the latter with the petiole; a wrinkled, crinkly and, in some cases, rather lacquered upper surface of the leaf. In one-year seedlings one sometimes finds buds arranged in groups, several of them on one common bud cushion—this should also be regarded as a good symptom. A well-manured heavy clayey soil is the best for seedlings of this group of plums. Generally, plums like a rich soil, and they easily stand even not fully decomposed manure. Humid soil is absolutely essential to them; on dry soil they thrive poorly, yield little fruit, frequently sicken and are generally short-lived.

The second group embraces plums with round or bulbous fruits. The best cultivated varieties of these plums are known under the name of Reine Claudes or Italian plums. The good features of these varieties are in part similiar to those of the first group: thick, but mostly short, shoots with closely-spaced buds and very strongly developed bud cushions; the bark of the shoots is in the majority of cases polished—more rarely, lustreless; the leaf blade is roundish, sometimes even somewhat shorter in length than in breadth, of average size, more rarely, large, and, in the best varieties, is nearly always exceptionally thick and wrinkled; the veins on the underside are very prominent; the dentation of the leaf edge is small and round; the petiole and main central vein are downy; the leaf is of a particularly dark hue. These plums are rather less exacting as to soil composition; they develop very well on black loams, and also tolerate a rather dry sandy loam, provided it is adequately manured and there is a humid clayey subsoil. On very dry, as well as on low-lying, cold and very humid soils, these plum varieties likewise grow badly.

In the third group I class Chinese, Japanese and the kindred American varieties of plums, in the cultivation of which I have suffered complete failure, and therefore cannot give any useful information about them.

In general, it should be said that when selecting seedlings of good plum varieties, and especially hybrids of such varieties, as few as possible of them should be discarded at a young age; judgment should be deferred until the first bearing, because they very rarely turn out to be altogether useless plants.

I, at least, have never met with such, with the exception only of varieties of inferior hardiness and fecundity.

Plum seedlings begin to bear at various times. Some of them bear their first fruits in their fourth year, while others only in their fifteenth year. The average bearing age of seedling plums is usually eight to ten years. Low-growing varieties, and those in the origin of which blackthorn or damson had a part, begin to bear earlier than the various Vengerkas.

Of the old cultivated plum varieties, I would recommend the following as having stones most suitable for planting with the object of breeding new hardy varieties: Green Reine Claude, Reine Claude Pontbriant, Black Reine Claude, Golden Reine Claude, Althann's Reine Claude, Washington, Jefferson, Anna Späth, Yellow Egg, Queen Victoria, Yellow Myrobalan. Of the semicultivated varieties, which are distinguished by great hardiness and are therefore most suitable for hybridization with the above-mentioned delicate foreign plum varieties, I would draw the attention of the amateur to the damson, which grows everywhere in our orchards and has small, round black fruits, and which in some parts is wrongly called chereshnik or large blackthorn. Our true blackthorn, and especially its large-fruited varieties, are also suitable for hybridization purposes. Of the new varieties that I bred and that are absolutely hardy in our climate, I would particularly recommend the hybrids of Green Reine Claude with the damson; the first place among them is held by the excellent in all respects, large-fruited Reine Claude which I named Reine Claude Reforma; then, as an annual bearer, I would recommend the Golden Reine Claude. I give in this article photographs of the fruits of both these varieties as examples of true acclimatization of the best Italian plums [see Figs. 15 and 16]. Among the plums with particularly large, oval-shaped fruits, I would mention Yaĭchnaya Severnaya, a variety of my own production; another of my varieties deserving of especial attention is Tyorn Sladky, derived from crossing Green Reine Claude with blackthorn, and Myrobalan Russkaya, the product of a crossing of Yellow Myrobalan with the blackthorn.

The principal criteria of excellence in the *sour cherry* and *sweet cherry* are: luxuriant growth of the whole plant, exceptional thickness of shoots, close spacing of buds, large size and thickness of leaf blade and petiole, large nipplelike knobs at the junction of the leaf with the petiole, and large number of these knobs. The latter symptoms are even more important in the sour cherries than in the plums. But not all these criteria may be applied in the selection of all varieties of sour and sweet cherry, because such signs as, for instance, size of leaf and thickness of shoots have significance only in the case of varieties that grow luxuriantly; these criteria are little valid in the case of the Morellos, the sweet cherries and their hybrids, or of varieties in the derivation of which our well-known wild steppe cherry (*Prunus Chamaecerasus*) had a part. In these varieties one often meets with some excellent and very fecund types that have small leaves and very thin shoots. As a graphic illustration, I give two photographs of new varieties of cherry hybrids of my own breeding, the first of which [Fig. 17], named Knyazhna

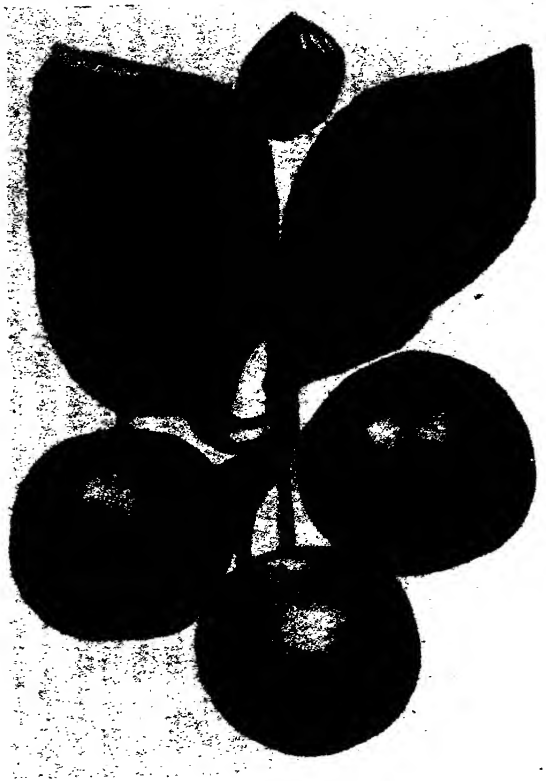


Fig. 15. Reine Claude Reforma. Hybrid of Green Reine Claude × damson (reduced)

Fig. 16. Golden Reine Claude. Hybrid of Green Reine Claude × damson

Severa,[1] unrivalled among our existing varieties of sour cherry both in respect to size of fruits and to their colour and flavour, was derived by crossing the Vladimirskaya Rannaya sour cherry with the Winkler White Cherry. The second variety, shown here [Fig. 18], which I named Michurin Plodorodnaya, and which is distinguished by amazing fecundity, was derived from the cross of the sour cherry described in *Vestnik Sadovodstva i Ogorodnichestva* as far back as 1889 under the name of Michurin Karlikovaya, with the abovementioned wild steppe cherry. Well, the first of these hybrid varieties is a model of luxuriantly-growing sour cherries, while the second has small leaves, and shoots so thin that it is fairly difficult to propagate it by grafting or budding.

Fig. 17. Knyazhna Severa (reduced)

I repeat, all the abovementioned criteria may be applied only when comparing closely-related seedlings or their parents, i.e., such as belong to one and the same natural variety, and on no account can each criterion be considered a rule for all seedlings in general.

Low-growing varieties of sour cherry enter their bearing age in their fourth year, but the tall sour cherries, and especially the sweet cherries, begin to bear only as late as their tenth or even their fifteenth year. The average bearing age may be taken to be between eight and ten years. The wild steppe cherry and its hybrids begin to bear sooner than all other natural varieties of sour cherry, and at the same time this cherry, and its Siberian variation, known as the Stepnaya Kurganskaya (which grows in the open in Omsk), show the greatest resistance to the frosts of the northern regions of Russia and are the most fecund; moreover, their fruit possess a strong fragrance, such as is positively not to be met with in any other strain of the different natural varieties of sour cherries, with the exception perhaps of the strain known as Gorkaya chereshnya, which is celebrated for its

[1] Subsequently renamed by Michurin: Krasa Severa.—*Ed.*

fragrance. In general, every originator of new sour-cherry varieties for our parts should pay serious attention to the virtues of the cherries just described.

Of the old cultivated varieties, I would mention the following as suitable for hybridization: Griotte d'Ostheim, Lotovaya, Lyubskaya, Double Natte, Roditeleva, Izbylyetskaya; and of the new varieties of sour cherry: the splendid large-fruited Podbelsky and my new varieties—Knyazhna Severa, Rogneda, Plodorodnaya [Michurin], Mindalnaya, etc. Of the sweet cherries, I have found Drogan Yellow and the Winkler White Cherry the best for hybridization.

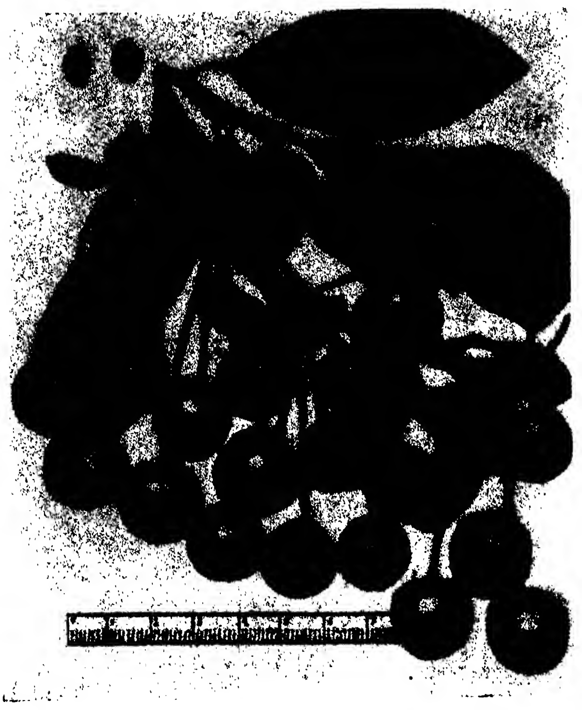


Fig. 18. Plodorodnaya sour cherry. Hybrid of Michurin Karlikovaya × *Prunus Chamaecerasus*

A light sandy and adequately nourishing soil, or a sandy loam mixed with marl may be considered the best soils in our parts not only for all varieties of sour cherry, but for the sweet cherries as well. The latter, however, i.e., the sweet cherries and their hybrids, although they develop best on rich loams, in our regions on such soils their fecundity and, what is more important, their hardiness are greatly diminished. For the training of sour-cherry seedlings, it is useful to add slaked lime to the well-worked and adequately manured beds, but the lime must constitute not more than one per cent of the soil in the upper one-quarter arshin layer (i.e., the dose must be even less than that recommended above for the ground under adult trees of the maternal plants designated for seed collection); otherwise, the lime will stimulate an even stronger growth of the fruit stones, which of course materially detracts from the value of all stone-fruit plants. Sour-cherry trees are badly affected by not fully decomposed manure, as well as by a superfluity of manure of any kind: it causes them to develop gummosis, and therefore, in applying manures to the soil, one must be extremely cautious.

Peaches and apricots. In our parts, ordinary seedlings of these species of fruit plants are killed by cold almost without exception, while the number of more or less hardy hybrids among them may be very few, and consequently there can be no question of culling the seedlings until they begin to

bear. It is far better to continue to train them until they have been bearing for several years, especially since in our regions, in Central Russia, such plants are of great value to every originator even if the quality of their fruit is poor, because more or less frost-hardy individuals can be obtained only from seedlings raised from the stones of fruits that have ripened on trees growing in the open. I want the amateur to note that this is the only method by which one can hope to acclimatize peaches and apricots in the central parts of Russia.

Peaches in general begin to bear in their fourth year; apricot seedlings much later. The average age at which the latter begin to bear is, on sandy soils, eight-ten years, but on loamy, more or less heavy soils, apricots delay bearing until their fifteenth year, and sometimes much later.

For the acclimatization of peach and apricot in our parts, the seedlings are best reared on a light sandy loam with a small admixture of marl. Rich, damp and, generally, low-lying cold soils should definitely be avoided. One must likewise be extremely cautious in applying various manures; in fact, they had better not be used at all if there is no great necessity for them. As to frost-hardiness, I must say that even in the first generation about five per cent of the apricot and peach seedlings, especially those grown from Caucasian and Turkestan varieties, suffer very little or not at all from the winter frosts; but on the eve of their first bearing (indicated by the fruit buds already formed in the autumn) such individuals for the most part perish in the spring from a ringlike injury that affects the bark of the stem near to the very ground. Hitherto, all measures I have taken to protect the trees from this injury have been unavailing. Grafting stone-fruit species onto the crowns of local stock only weakens the resistance of the branches themselves, and the grafted shoots are killed by cold in the very first winter. Only very lately have I been getting substantial help from a hybrid of the peach with the Amygdalus Posrednik [Intermediary] which I obtained by crossing *Amygdalus nana L.* with *A. Davidiana*. But complete success is still a matter of the future; several generations will have to be trained.

Grape. It should be said that, of all the species and natural varieties of grape, the most suitable for the breeding of new hardy strains for our parts have proved to be the semicultivated *Vitis riparia Michx.*, or *V. vulpina L.* from Canada; then follow Central Asiatic seedlings of the natural varieties of *V. vinifera L.* that grow there, although the latter are far inferior in respect to hardiness than the two former. As to the European varieties of *Vitis vinifera*, they have practically all proved to be quite unsuitable for acclimatization in our parts. From plantings of Canadian and Central Asiatic grape, I have obtained several quite hardy strains that require no artificial protection in winter, except bending the vines to the ground; and some of them even live through the winter without this.

I have not succeeded in obtaining a single hardy seedling from any other natural variety of grape, not even excluding the Ussurian and North Chinese, although I have made a fairly large number of plantings. Further, all the varieties of the cultivated grape of the species *V. labrusca L.* and its

hybrids, which are considered the most hardy in North America, including Isabella, known for its hardiness in our southwestern provinces, I have found in my work to be of poor resistance, and unless the vines are covered over with earth for the winter, all without exception freeze to the roots.

The first selection of grape seedlings is made in their first year, after the first winter, the criterion being their resistance to frost. In the second summer note is taken of those seedlings the vines of which begin to mature earlier than the others. This can usually be judged from their turning brown and woody, a process that always begins from the very bottom of the vine, at the root collar, and then gradually mounts upwards. The future ripening period of the new variety's fruit may be infallibly judged by the time of the initiation of this maturing and by the progress it has made along the length of the shoot, since in all natural varieties of grape generally these two phenomena always proceed simultaneously. This selection by the criterion of early maturation is of great importance in the breeding of new, hardy varieties of grape suitable for cultivation in the open in the central and northern parts of Russia; firstly, because all varieties, the vine wood of which ripens earlier prove to be the most frost-hardy; secondly, because the earliest-ripening varieties are better guaranteed against their fruits being caught by early autumn frosts; and, thirdly, because only the earliest-ripening varieties of grape can have any value in our markets, since a bigger and more profitable sale is assured only to those varieties that can be offered in our markets before grapes brought in from the South appear, with which our young northern varieties are still unable to compete. But I make bold to assert that this state of affairs is only temporary, that it is due, not to the climatic conditions of our parts but exclusively to the insufficiency of grape varieties fitted for these conditions, and that in the future these defects will be easily eliminated by breeding from seed new varieties with greater virtues. Meanwhile, one of the chief problems in this field has been solved: early-ripening varieties have been obtained that possess a high degree of resistance to frost in our localities without any protection in the winter. These varieties, although in many respects they fall short of the southern cultivated varieties, are destined to play a very important role in the future as the progenitors of grape varieties that will be hardy in our regions.

The two first grape varieties that I have produced are called Severny Bely, a cluster of which, somewhat reduced, is shown on the photograph [Fig. 19], and Severny Chorny.

It should be said about the grape in general that, notwithstanding the fact that it is a plant of warm climes, the seedlings of some of its natural varieties are capable of adapting themselves to climatic conditions in which even our common apple varieties cannot develop successfully. Incredible as this statement may seem, it is an undeniable fact. For example, in Dr. Safaterov's orchard in the town of Belebey, Ufa Province, a grape vine produced by Mr. Khramov in Kazan from the seeds of the Tashkent grape is growing and bearing in the open without any protection. Further, in Barnaul, Tomsk Province, a vine grown from seed by Mr. Pavlovsky has also been growing

in the open for several years. It was undoubtedly only due to a gross error of the horticulturists that the development of grape cultivation in our parts has been retarded: until now they have experimented solely with varieties bred in warm climates, and have therefore always suffered complete failure. This was contributed to by the fact that even if anyone did succeed in growing grape from seed north of its zone of cultivation, the plant was allowed, from lack of knowledge, to grow without the necessary pruning, without which even the best cultivated varieties produce fruits and clusters of small size; nor was selection of cuttings practised for the propagation and improvement of each new variety, etc.

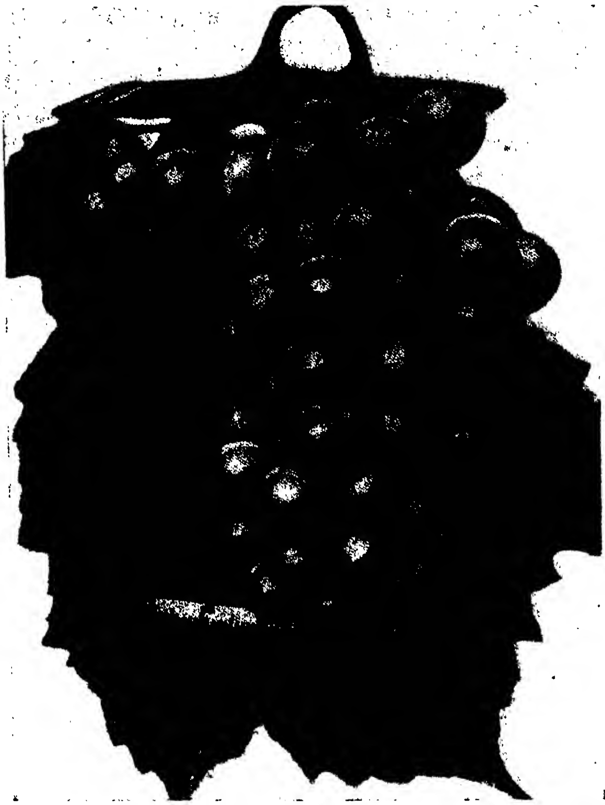


Fig. 19. Severny Bely grapes (*Vitis riparia*). Novelty, 1906, ripened by July 30

Seedlings of *Vitis riparia Michx.* for the most part enter their period of bearing in their third or fourth year, Central Asiatic seedlings rather later, while the European seedlings begin to bear later than all; they sometimes remain barren for over ten years.

In order to induce the vines to begin to bear at the very earliest, one should endeavour to make them grow as sturdy as possible by leaving not more than two shoots on each vine. All the other shoots should be cut off from the root collar as soon as they begin to develop. The main vine should be no less than six arshins high, and the growth shoot must therefore not be pruned; on the contrary, it should be protected against all injury until the autumn, and only then, after the leaves, which are usually killed by the first frosts, have fallen, the vine should be shortened by pruning to a length of not more than 1½-2 arshins. It should then be bent to the ground for the winter, and in the spring raised again and tied to poles in an erect position. In the first two or three years of bearing the final selection of the best seedlings is made, this time according to the quality of the fruit. It should be remarked that grape seedlings often suffer from a very serious

defect: the sex organs in the flowers fail to develop fully; some individuals have no pistils, i. e., female sex organs, at all; more rarely, an absence of stamens is observed. Sometimes these defects disappear in the second or third year of blossoming, and the structure of the flowers becomes complete; but the majority of such individuals remain unaltered and, of course, are quite incapable of producing fruit. Sometimes these defects are to be found in certain new, and even old, varieties not on the whole plant but only on a part of it, on some of the branches of the vine. And so, when propagating any new variety by cuttings, strict care must be taken that none of the cuttings come from such imperfectly developed parts of the vine, otherwise the individuals that arise from them will be barren. Similarly, selection must be employed to eliminate other defects, e.g., imperfect structure or small size of the clusters or of the grapes themselves, uneven size or incomplete development of the latter, etc. Seedlings are also rogued that are inclined to root rot, chlorosis or other diseases. When selecting from already bearing seedlings, besides early ripening of the fruit, attention should be paid to unusually late movement of the sap and later blossoming; such individuals are of great value in our parts because they more easily escape being damaged by late morning frosts, which occur not only in our parts, but in more southern countries as well, where vineyards suffer heavily from them.

Although the grape cannot in general be considered fastidious as regards soil composition, nevertheless both the physical and chemical properties of the latter have a great influence on the development of the plant itself and of its fruits. Generally, although soils of light or medium consistency that are quickly warmed and that retain only the amount of water necessary for the vital processes of the plants promote only moderate growth, yet the fruits raised on them possess better taste qualities. Cool, deep, fertile soil, on the other hand, promotes profuse growth and abundant fruit, but the product is of mediocre quality.

On examining the influence of physical properties of the soil, we note that black, red or brown soil which more rapidly absorbs heat rays and radiates them at night enhances the development of the root fibrils and enables the fruits to retain a relatively higher temperature all through the ripening period, with the result that they acquire a sweeter taste. Whitish soils warm up in the spring slowly, since they reflect a large part of the heat rays falling on them; on such soils the root fibrils develop late, and burns are frequent. The grapes are smaller, but on the other hand, more sugary. Stones, or, better still, broken brick, are an important factor in changing the properties of the soil: they help to warm it, as they absorb more of the heat rays, increase its permeability, and prevent superfluous evaporation of moisture, and thus help to improve the quality of the fruits. The chemical composition of the soil likewise has a big influence on the plant and its fruits. Plots in my nursery that were given a potassium mineral fertilizer produced vines of medium growth and fruits of small size; with a nitrogenous fertilizer (Chile saltpetre), the vines gained powerfully in growth and the grapes were larger, but had a watery taste. The addition of lime to

the soil yields good results in all respects, but apparently disposes the plants to chlorosis. Dry soils add to the sugar content of the grapes, whereas very humid soils lend them a watery taste.

For the grape vine to grow rapidly and luxuriantly, the earth must be deeply dug over, to a depth of from 1 to $1^1/_2$ arshins, so as to thoroughly mix the particles of the soil, as this answers to the natural and vital requirements of the vine. One must be extremely cautious as regards the application of organic matter, especially insufficiently decomposed manure, because the grape tolerates it but poorly, and the seedlings as a result of such manuring often suffer from root rot, with consequent detriment to the quality of the fruit.

I have obtained my best results on a loam-turf soil to which had been added coarse sand, peat and broken brick from old buildings, treated with a liquid manure made of a well-fermented cheap-quality carpenter's glue in very weak solution. Electrical treatment of the beds has a very powerful effect in promoting luxuriant growth in young grape seedlings, but here again I must repeat that the tension of the current must not exceed $1^1/_2$ volts; a stronger current, I have observed, has a harmful influence on the healthy development of the plants.

The grapes of the first bearing usually do not attain the size and abundance that may be achieved subsequently.

Development of the best qualities should be facilitated by careful selection of cuttings, repeated layerage of the best parts of the vines, relatively close pruning, and planting on the best soil.

The best seeds for planting, in respect to the hardiness of the future plants, are provided by the semicultivated grape varieties from Canada belonging to the species *V. riparia Michx.*; relatively more hardy are seedlings obtained from seed of cultivated varieties growing in our Central Asiatic parts and in the Caucasus. Of the varieties of western origin with relatively greater hardiness (provided, of course, the vines are covered for the winter with earth) and early-ripening properties, I would mention the following: Malingre, Madeleine Angevine, Spanish Chasselas rouge, the Early-Maturing Saumur. Of the American varieties: Green Mountain, Campbell Early, Moore Early, Early Victor. For outstanding size of fruits: Black Defiance and our Caucasian Dodrelyabi; in my orchard, seedlings of the latter prove to be much more hardy than the European Gros Colman, which is considered one and the same variety as Dodrelyabi. The well-known variety called Aramon is considered the most outstanding for yield, but unfortunately the taste of its fruits is poor. Also good for hybridization purposes are the best varieties from our Central Asiatic parts: Ozbek-Oldiren, Akish-Kirek, Paizi, Charasu, Fusaine, Parkent, etc. Of course the hardy grape variety of my own breeding as well as Safaterov Belebeyevsky, Pavlovsky Barnaulsky, Getsh Kozlovsky and Shilyin Kozlovsky are in the front rank as regards hardiness.

Currants. Seedlings of this berry plant, when trained on rich and, what is most important, sufficiently moist soil, with few exceptions produce berries that are almost all of good quality and in no way inferior to the best cultivated varieties, which, incidentally, differ very little from one another. If

there are a large number of seedlings, the criterion for the first selection may be comparatively greater sturdiness of development in the first year of growth; the last selection should be made when the seedlings are at the age of three or four, the criterion then being quality of the berry.

Currants usually begin to bear at the age of three or four. All individuals not distinguished by abundant yields, or producing small berries, should be destroyed. Practically all varieties of currant like a rich and porous soil with a constant and adequate supply of moisture; if the beds in which the seedlings and the older plants are grown are on elevated ground, they must be protected from excessive dessication by covering the soil with a fairly thick layer of manure, otherwise the results of the culture will be anything but good.

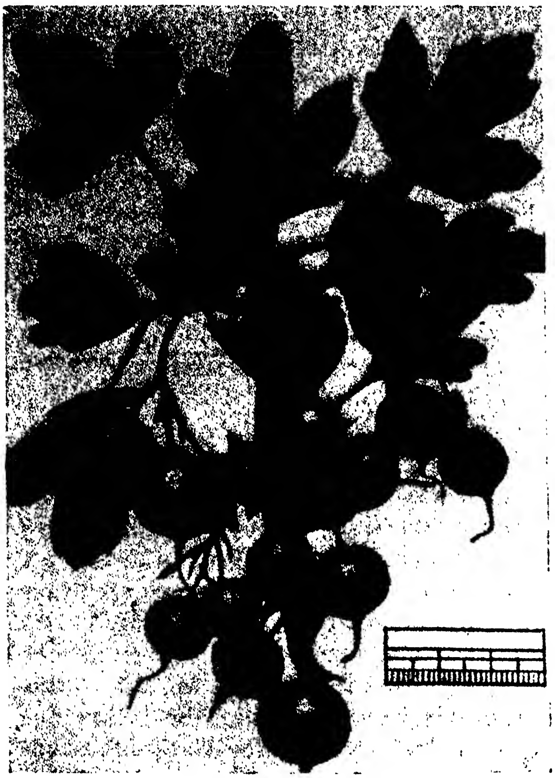


Fig. 20. Black currants of Crandall seedlings (Undina)

Of the various species and natural varieties of currant several strains of the species *Ribes aureum* I have bred from seed of the Crandall, an American variety of this currant, and introduced into cultivation, are particularly deserving of the attention of horticulturists.

These new varieties are distinguished by amazingly high yields, large berries, good flavour when made into jam, and tiny, scarcely visible seeds. I give here a photograph of the berries of one of these varieties in their natural size [Fig. 20]. The berries of these new varieties are of various colours—black, red or amber yellow.

Of the old cultivated varieties, I would mention the following as the best:

1. Red: Fay's Prolific, Impériale rouge. 2. White: White Versailles and White Imperial. 3. Black: Lee's Prolific, Bang-Up, Black Naples and Ogden's Black.

Of the Siberian species, the following varieties are interesting: Yanitsky Buro-Krasnaya, which has large dark-red berries some 2 cm. in diameter; Sinaya, also called Okhta or Aldansky Vinograd, with large black berries;

Mokhovaya, which belongs to the group of black currants, but has berries with a pleasanter taste and fragrance; Kyzyrgan, which produces a dark purplish berry but of better flavour and fragrance than the red currant. I repeat, these varieties are very interesting for hybridization; valuable new varieties might be produced from them.

I cannot refrain from mentioning here the currant varieties called Bessemyankas [Seedless] one meets with in commercial establishments. In my experiments with these varieties, they have proved to be utterly worthless because of their low fecundity. There have been some among them on the bushes of which I did not see a more or less decent yield in ten years. The berries for the most part grow not in clusters but singly, and are always very limited in number. In a word, all these varieties must be regarded as unsuitable for commercial growing. It is another matter if one regards them as producers, that is, makes use of their seeds, which are nevertheless present in nearly every berry of these varieties, although, it is true, in a far lesser amount than in the common varieties. One might hope, by means of selection, to obtain from seedlings of this currant new varieties both with a high yield and a small amount of seeds, which, of course, would be an outstanding quality in a new variety because of its greater suitability for jam-making.

Gooseberries. To breed large-fruited varieties of gooseberry from seeds, one requires a rich, porous loamy soil and a site slightly shaded from the heat of the sun. The seedling beds must be constantly kept in a moist state; the soil must be frequently hoed and kept thoroughly cleared of weeds, and, moreover, in June and July the plants must be given a dressing of liquid manure made of well-fermented guano with the addition of nitrogenous mineral fertilizers, of which the most suitable is Chile saltpetre. The dressing must not be applied before the seedlings have developed their fifth leaf and their roots are sufficiently sturdy, otherwise the seedlings easily contract root rot and die in masses. Here, too, electrical treatment of the beds may considerably help the seedlings to absorb the nutritional substances from the soil more rapidly, and hence to develop more luxuriantly. On dry sandy sites, especially with a southerly slope, large-fruited varieties are never obtained from gooseberry seedlings, and therefore such sites should be avoided when breeding new varieties of gooseberry from seed. The largest-fruited, world-famed gooseberry varieties were mostly produced in England, with its foggy and humid climate, and on soils which were heavily manured.

It is precisely the seeds of English varieties that must be considered most suitable for the production of new, large-fruited gooseberry varieties. Then, for hybridization with the purpose of obtaining varieties more resistant to our climate, the most suitable are our semicultivated and wild varieties of gooseberry growing in the Urals. The fact that most of them are either altogether immune to mildew infection, or, if they do happen to contract it, suffer very little from it is an additional very valuable feature. Their leaves apparently do not offer a favourable medium for the development of the mould. This virtue is also possessed by certain American gooseberry varieties,

of which, on the basis of my tests, I can recommend the following two: Green Mountain and Columbus. Very good in this respect are several varieties bred by the late Mr. Kuzmin in Vetluga.

The chief symptoms of good qualities in gooseberry seedlings are likewise: comparatively greater luxuriance of growth of the whole plant; thicker, shorter shoots; greater size and thickness of leaf blade; dark green lustreless colour of the leaf, and shorter and broader thorns. Complete absence of the latter should also be regarded as a good feature in the seedling, and such individuals, even if they do not have other good qualities, should be cherished, because subsequently, when crossing them with other varieties, it may be possible to obtain good, large-fruited thornless varieties, which, of course, would be of immense value, since the gathering of the fruits from such plants would be greatly facilitated. Further, when selecting, preference should be given to seedlings with smooth, non-hirsute berries of a green colour, for it is only kinds with such qualities that the buyers mostly demand.

Of the gooseberry varieties I have tested, I would recommend the following large-fruited ones: Green Willow, Aaron, and the hardy variety of Russian origin which I obtained from Mr. Anibudov and named after him Anibud. Of the red-coloured: Industry, Brigg and Avenarius. Of the yellows: Yellow Lion and California. Of the whites: Columbus. The first fruits usually appear on gooseberry seedlings in the third or fourth year after germination from the seed. The gooseberry, as well as the currant, is hard to hybridize, because the reproductive organs of these plants are very small, and, moreover, the flowers are extremely inconveniently placed on the branches, making it difficult to effect castration and fertilization.

Raspberry. This unfastidious plant is content almost with any soil, although, of course, in better soils it produces larger berries and the yield is considerably higher. For the training of its seedlings, the beds must be dug shallow, one spade's depth is quite sufficient. The composition of the soil must be light, but as nutritious as possible; the best results are obtained with a mixture of half-turf, half-leaf mould, with the addition of coarse sand and peat; when one- or two-year seedlings are planted, soil of this composition needs the addition of well-decomposed manure. Generally, the raspberry prefers rather superficial manuring, and it is therefore best to cover the seedling beds with a layer of friable manure and now and then to give it a liquid dressing.

Selection of seedlings should be based exclusively on the sturdiness of development: other symptoms can only be judged by comparison with the parent plants. In general, raspberry seedlings begin to bear in the third year, and only as the result of negligence and poor care, when the soil is too dry and unnutritious, is the bearing of some of the seedlings delayed until the fourth year; but nothing good is to be expected from such starvelings anyhow, and it is more profitable to destroy them. As one of the best varieties for the collection of seed, I would recommend the Marlboro, because of its most exceptional resistance to frost—so that even the ordinary expedient of bending the

canes to the ground for the winter is unnecessary in our parts—and chiefly because practically all its seedlings come to bear fruit with good qualities. This variety, if its seedlings are well tended, practically never degenerates. Good for this purpose are also, of the old varieties, Fastolf, and of the new, Logan and the variety bred from its seed which I have named Texas [see Fig. 21]. This latter variety has a remarkable yield, attaining to fourteen pounds of berries per bush, and the berries are of outstanding size. Of the black varieties, I recommend the American raspberries known as Eureka and Gregg. Of the white—Golden Queen. Crossing of different varieties of raspberry is easily performed and is always successful; and, on the first flowering of the seedlings, they can also be successfully crossed with the blackberry and with species fairly remote from them, but not with the various species of strawberry. Such conjuring tricks are so far possible only in America. I am now, in my nursery, observing with great interest the development of a remarkable hybrid obtained by crossing the Texas raspberry with the Izobilnaya blackberry. Both immediate parents are distinguished by abundant yield and outstanding size of berries, and their parents likewise had these distinguishing features. This hybrid seedling, selected from a total of fifty, stands out for its very luxuriant growth, and will rank among the best blackberry varieties.

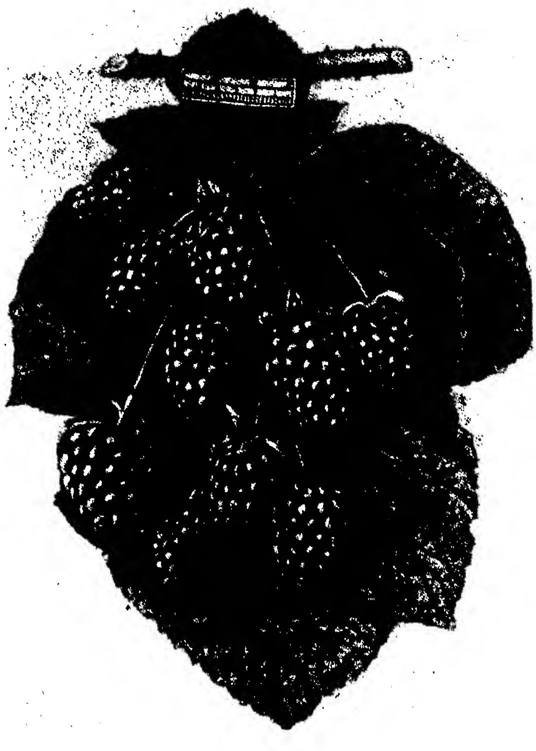


Fig. 21. Texas raspberries. Selected seedling of the loganberry

Blackberry. Much of what has been said about the training of raspberry seedlings also applies to the blackberry. A sandy-silty soil of moderate humidity best answers the requirements of blackberry cultivation. On rich black-earth soils, this plant develops too profuse a growth, to the detriment of fruit yield, and, moreover, the plant itself becomes less resistant to winter cold. One should therefore avoid cultivating blackberry on too rich a soil. The earth must be worked to a far greater depth than in the case of the rasp-

berry, because the roots of most species of blackberry are more vertical and penetrate to a considerably greater depth.

Blackberry seedlings yield their first fruit in the third year. Of the best varieties for the collection of seed, I would name, as most suitable: Lucretia and the new variety I have bred from seedlings, Izobilnaya [see Fig. 22], which is distinguished for its generous yield and remarkably large berries. Then: Stone's Hardy, Stachellose, Taylor, Rathbun, Peschannaya, Hansell, Kittatinny, etc.

Fig. 22. Izobilnaya blackberry. Selected seedling of Lucretia blackberry

By their external appearance, all cultivated varieties of blackberry may be divided into two groups. The first embraces varieties possessing rambling shoots, e.g., Lucretia and Izobilnaya; the varieties of the second group have erect shoots, e.g., Stachellose, Stone's, etc.

In view of the fact that all known blackberry varieties, when cultivated in our parts, have to have their shoots bent to the ground for the winter and covered with weeds, if only lightly, in order to ensure accumulation of snow on the beds at the beginning of winter, I consider only varieties of the first group convenient for cultivation in our regions, because their shoots are far more easily bent down for the winter. In the case of the varieties of the second group, this operation is very difficult to perform—in spite of every care, the thick and extremely tough shoots very often break off at the very base.

The symptoms of good qualities in young seedlings are: sturdy development of the whole plant; leaf blade of large size and with a crinkly and wrinkled surface; thick shoots; relatively large stipules, with even, slightly indented edges; early darkening of the colour of the shoots in the autumn (a sign that the shoots are fully matured), etc. Then, of course, it is desirable to have varieties with as few thorns as possible, as is the case with the above-mentioned Stachellose blackberry; it would be still better if varieties could be bred without any thorns at all, for this would considerably facilitate tending of

the plants, and especially gathering of the berries. When hybridizing blackberry with raspberry, besides obtaining greater fecundity and size of berries in the new varieties, the chief aim of the originator should be to secure a hybrid whose berries will be fragrant and have the tiniest and smallest number of seeds possible. With this end in view, crossing of the blackberry with our wood raspberry, because of its excellent fragrance, should be performed on a large scale.

Of the various compositions of manure that I have employed in rearing blackberry seedlings, the best results were obtained from mineral fertilizers and electrical treatment.

It would be very interesting to produce hybrids of blackberry with the plant that has appeared in commercial nurseries under the name of "raspberry-strawberry." Although the berries of this plant are entirely useless for use as food either in the raw state or in the form of jams, nevertheless, if hybridized with blackberry or raspberry, among the seedlings very valuable varieties might be obtained possessing a well-flavoured berry and, in addition, the property of bearing fruit only on one-year shoots of the same year, and at the end of the autumn losing all the overground parts of the plant, as occurs with the "raspberry-strawberry." It goes without saying that such a property would be a big virtue in a new variety, since it would avert the necessity of bending down the shoots for the winter. The same should be said of the yellow Chinese blackberry; moreover, the berry of this variety has an excellent flavour and a very handsome bright golden hue. Unfortunately, its yield is very small.

Various species of strawberry. For the second replanting of the seedlings from the planting boxes (which were described above), it is sufficient in the case of these plants to dig over and manure the beds to a spade's depth. The best soil for the cultivation of these plants is a turfy loam, well manured with a thoroughly decomposed two- or three-year-old dung, with an addition of peat and coarse sand. Light (i.e., very shallow) raking of the surface of the beds between the plants, maintenance of the soil in a constant state of moderate humidity, thorough weeding, application of liquid manure several times in the course of the summer, protection of the seedlings from excessive heat of the sun in hot weather, removal of the runners as they develop, and covering the surface of the beds with fine black peat are absolutely essential when growing seedlings of the various species of strawberry with the object of producing new large-fruited varieties. Here, too, electrical treatment of the plants is of immense value. I want to remark that this regimen is applicable only to the rearing of seedlings belonging to the different species of strawberry; it is not suitable for the ordinary cultivation of these plants for cropping, because it diminishes the yield from the plantation by encouraging a too luxuriant development of the plants.

The seedlings begin to bear early; not infrequently the best and most successful individuals bear fruit already in the first summer, and in the second summer, after the seedlings have been planted out into the beds, most of them yield fruit. Plants that have not begun to bear in the third year had better be

destroyed, because such individuals are rarely fit for cultivation. It is better to effect selection of the seedlings from those already bearing, quality of the fruits and yield being the criteria.

Crossing between cultivated varieties belonging to different species of strawberry presents no difficulty, but the wild forest representatives of these plants are very little amenable to hybridization with cultivated varieties. In such cases it is better first to grow seedlings of the wild natural variety from seed, and only then, when they first blossom, to perform the crossings with the cultivated varieties. Not infrequently, among a thousand seedlings of the wild species only one individual may be obtained suitable for crossing, while the rest prove absolutely incapable of blossoming. This is a direct consequence of the fact that the wild species of these plants have for many centuries propagated, not sexually, from seed, but exclusively vegetatively, by runners, as a result of which they have lost the capacity to produce normally-constituted plants from their seeds. Fortunately, this defect rapidly disappears in the hybrids, and in the third generation of seedlings it is already unnoticeable, in spite of the fact that even cultivated varieties often display similar shortcomings.

Both for seed collecting and for hybridization, I would recommend the following varieties: Louis Gauthier, Noble, Sharpless, Jucunda, Vorka, King Albert, A. Coch, Monarch, and White Pine-Apple; of the latest varieties Deutsch-Evern is also good. Of the large-fruited strawberries: Belle Bordelaise, Royal-Hautbois, and Muskusnaya Rozovaya. Of the perpetual strawberries which bear all through the summer: Gaillon, Blanche d'Orléans, White and Red Anhalt, St. Joseph and Jeanne d'Arc. Of the improved wood strawberries: Bargemont and L. M. Redko. Also very suitable for hybridization is our wild wood strawberry, being a variety distinguished for the unusually strong fragrance of its berries and their firm, sweet flesh. Unfortunately, hybridization of this strawberry with the cultivated varieties of our large-fruited strawberries of another species is very difficult, and, moreover, the hybrids obtained, in their first generation, produce fruits very little distinguishable from those of the wild species, in spite of the fact that the maternal plant in the crossing was the cultivated large-fruited strawberry. And the yield of these hybrids is only greater if the beds are closely and compactly covered with the plants. In the last issue a photograph was given of one of the plants of these hybrids, obtained in the first generation after crossing [see Fig. 23].

Concluding these brief extracts from a fuller work that is being prepared for the press—*Handbook of Practical Information, as Material for Future Work on the Compilation of a Guide to the Production of New Varieties of Fruit Plants from Seed*—I deem it necessary to say that the science of intelligent breeding of new varieties of fruit plants from seeds is in our country still in its initial stage of development, and, unfortunately, we have such little information to serve as guide in the proper conduct of this work that it is still impossible to compile anything that would be systematically correct.

I therefore beg the reader to make allowances for the faults of my article such as: firstly, the account of the results of my observations being in places fragmentary and lacking consistency and coherence in its various parts; secondly, many of the facts being given without an explanation of their causes, or the causes improperly interpreted; thirdly, the very conspicuous absence throughout the article of much essential and important information, which, in spite of my best wish and endeavour, I have been unable to acquire, and, moreover, some of the problems have been beyond my power to solve.

But despite the serious defects in my work, I nevertheless venture to hope that it will be of considerable use to Russian horticulturists, while the shortcomings will in the course of time be repaired by other practical workers in the field. Where I have failed, others will learn to succeed; what I have erroneously understood, still others will correct, and so on.

Further, I deem it necessary to warn Russian horticulturists against the traditional infatuation for everything foreign, including various theories of breeding new varieties of fruit plants prevalent in Western Europe or America. However ingenious these theories may be, however talented may be the horticultural practitioners of these countries, it is not they that can help us in our work, nor is it in the results of their work that we shall find the pivot for our success, because in the matter of producing new varieties of plants, more than in any other, one cannot apply methods elaborated in climatic conditions entirely different from ours. We must stir our own forces to greater activity, we must carefully examine the climatic and other conditions of our regions, and thoroughly study their peculiarities. Only then will it become perfectly evident to every Russian practitioner that nearly everything foreign in this field is quite unsuitable for our purpose. There is nothing surprising in the successes, say, of Burbank in America, over whom such a stir has been raised; he has achieved successes of such dimensions, not because of the methods he employs, but solely because of

Fig. 23. *Fragaria moschata* hybrid (reduced)

the substantial material support his work has received both from society and from the government; this has enabled him, without stinting himself, to build his work on broad lines, and to train hundreds of thousands of plants on several score acres of land.

That, mark, is very far from what we have here in Russia.... Take myself as an example. For thirty-three years I have had to toil and moil on wretched patches of land, to deny myself utter necessities, to tremble over every farthing spent, and to try to recover it, to win it back, as quickly as possible, so that I might be able the following year, one way or another, however inadequately, to train an additional dozen plants, sometimes, with bitterness at heart, destroying valuable specimens solely because there was no available space for other plants.... And what is the result? After thirty-three years of labour, after having produced many evidently valuable new varieties of fruit plants—practically no interest or attention on the part of society, and still less on the part of the government, in spite of my repeated applications and petitions. And as to material support, the less said the better —that you can never expect for a useful cause in Russia. And so, in the end, the work is going to rack and ruin, the nursery is rundown and neglected, two-thirds of the new varieties have either perished, lost for lack of proper care and necessary space, or have been distributed among various purchasers in Russia and abroad, whence they will return to us under different names. Health and strength are failing, and, willy-nilly, I shall have to part with the vocation I love and, although gradually (for many of the plants are only entering on their bearing age), wind up the work altogether....[1]

First published in 1911 in
*Progressivnoye Sadovodstvo
i Ogorodnichestvo*, Nos. 1-32

SOME INTERESTING FEATURES OF THE INFLUENCE OF PARENT PLANTS ON THE CHARACTERS AND PROPERTIES OF THEIR HYBRIDS

A thing that every plant hybridizer should bear in mind is the following. In natural cross-fertilization, where every maternal plant has the opportunity of, so to speak, freely choosing—out of all the wind- and insect-carried pollen, sometimes from quite a few different varieties—the pollen that is best suited to the structure of its particular fruit-forming organs, the progeny consists of relatively more viable individuals. The latter cannot always be expected in hybrid seedlings, which are obtained by artificial and, of course, enforced crossing; for the hybridizer may quite often cross varieties whose

[1] This was so in tsarist times. From the Soviet State I. V. Michurin received support and material facilities for his work that were beyond all comparison with the insignificant dole received by Burbank in America.—*Ed.*

mutual interaction not only destroys the influence of the hereditary transmission of the best characters of their fruits or flowers, but may even make the hybrids incapable of properly forming certain vital organs; in consequence of which these hybrids cannot exist unless artificially assisted by man. Now among such hybrids one not infrequently encounters specimens of great value to the hybridizer, and these must therefore be maintained in existence by artificial means until their characters and properties have been fully ascertained.

Let me quote an illustration which will give the reader a much clearer picture of such phenomena. Among my numerous hybridization experiments, I had occasion to cross a hybrid of the Damask rose and the Capuchin Persian Yellow rose with the Polyantha Rose known as the Clothilde Soupert; and the resultant hybrid seedling proved to have such a poor root system that, in order to save it from imminent death, I had to move it with all speed to other roots; which I did by bark grafting it, when it had only sprouted its fourth leaf, upon a seedling of *Rosa canina.* (Such grafting is usually successful only if the hybrid, bark grafted onto the stock as a green cutting, is protected by a glass cover.) And afterwards this hybrid developed into a very fine attar rose variety, with perfectly formed full double pink flowers and a delightful and remarkably strong fragrance. A trial steam distillation by means of a small laboratory still showed that the flowers contained a much higher percentage of attar than the regular Damask rose. (This rose variety, which I have called Slava Sveta, is described in detail, with a photograph of the flowers, in the *Vestnik Sadovodstva, Plodovodstva i Ogorodnichestva* for 1907, No. 7-8.) It is also in place to call the reader's attention to the very interesting fact that this hybrid has such remarkably fragrant flowers while the external appearance of its other parts, as for example the shape of the leaves and shoots, is completely identical with those of the Capuchin Yellow Rose—in consequence of which this new variety has been classed with that species. It is quite evident here that the hybrid derived only the shape and structure of its flowers from the paternal plant, namely the Clothilde, and all its other properties came from its grandfather and grandmother. Its strong flower fragrance was inherited from the grandmother, the Damask rose; and it is interesting that the disagreeable odour of the flowers of the grandfather plant—the Capuchin Yellow Rose—far from spoiling this fragrance, considerably intensified and improved it. Further, the outward appearance of the new variety's leaves and shoots is inherited entirely from its grandfather, the Capuchin Yellow Rose. Thus, this instance too—as most others, with very few exceptions—bears out that hybrid plants derive their characters and properties not from the immediate parents, the father and mother, but from the grandfathers and grandmothers, in different combinations of their properties.

First published in 1913 in
Sadovod, No. 9

A SURER WAY TO ACCLIMATIZE PLANTS IS BY DEVELOPING HYBRIDIZATION

After working for many years in the field of plant acclimatization, I feel justified in saying, with full assurance that my conclusion is not mistaken, that the best way to acclimatize plants is to introduce them in the new locality by planting their seeds. For when you transplant complete specimens or parts of them, in the form of cuttings, many of them cannot entirely adapt themselves to the new climatic conditions, no matter what ingenious changes and combinations of methods are employed; and this is often the case even when these conditions would appear to be much better than in the plant's native habitat. Let me quote, as the most striking, the case of the long-known Siberian wild apricot (*Prunus sibirica L.*). In its place of origin, in the vicinity of Nerchinsk, this plant freely endures temperatures as low as -45°R., even without the protection of snow. Yet here in Central Russia it is killed regularly by 27° of frost, and can be preserved and made to bear fruit only given substantial protection in the winter. The same holds for certain other Siberian plants. Still more does it apply to more tender varieties, natives of places with warmer climates than ours; of these, the only ones to survive transplanting to our parts are such as already possessed at home the ability (if only latent) to endure temperature drops equal to ours. Such plants are usually, and erroneously, cited by way of proving that acclimatization can be accomplished by introducing grown specimens; but examples of that sort prove nothing at all, and to base one's conclusions on such misapprehended phenomena is, to say the least, a grave error. For really, I ask you, where is the acclimatization here, what does it consist in? Why, the newly-introduced plant proves hardy only because it was already hardy in its native surroundings.

Mr. Voyeikov tells us[1] that the French Acclimatization Society hoped to cover the whole of France with eucalyptus groves and plantations of cotton, sugar-cane, sweet potatoes and jute by shifting the plants, generation by generation, further and further to the north. A whole succession of experimental gardens was laid out for this purpose—in Algiers, on the Riviera, at Lyons and in Paris. But of course, Voyeikov adds, not one of the hundreds of experiments was successful. Unfortunately, he does not specify the method by which the plants were moved—whether in the form of seeds or of grown saplings. Mr. Voyeikov did not ascertain this very material point. It is possible that the French moved the plants in the form of grown saplings, and in that case their failure to secure acclimatization is easy enough to understand. But even supposing the plants were moved northward gradually in the form of seeds gathered at each preceding, more southern experimental station—even then the partial failure of the experiments would not constitute sufficient proof of its being impossible to achieve acclimatization, even on the ambitious scale that Mr. Voyeikov attributes to the French acclimatizers; because in

[1] In his article "The Naturalization of Forest Trees," *Lesnoi Zhurnal*, 1908, No. 7.

this latter event the failure could only have been, and in all likelihood was, due to improper selection of seeds for planting. The fact is that, while propagation from the seed must be considered the surer method of acclimatization, yet it has to be borne in mind that not all seeds produce plants with an equal capacity for acclimatization, and that seedlings of the majority of pure types can alter their properties only very slightly, and consequently adapt themselves with much greater difficulty to new conditions than, say, seedlings raised from hybrid seeds; moreover, the more distant the kinship between the crossed parent varieties, the better can the resultant hybrid seedlings adapt themselves to the conditions of a new locality, and vice versa.

As has long been ascertained, every seed of a plant carries within it in embryo a large proportion of the future characters and properties of the plant that will grow from it. From the time that the plant begins to develop from the seed and to that of complete maturity, these characters and properties can change under environmental influences only within certain strictly defined limits. Now the extent of these limits stands in inverse ratio to the degree of the given variety's constancy. I repeat, purebred plants are the most constant, and are accordingly less able than others to alter their properties; for this reason they are much harder to acclimatize. Next come the more long-standing varieties, which, during the long time that they have been in existence, have developed a sturdy resistance to change; next in order are varieties of more recent origin bred from closely related parents; then varieties also of recent origin, but derived from more distantly-related parent plants; and, lastly, interspecific hybrids, also of recent date; the latter should obviously manifest the greatest degree of changeability and should consequently adapt themselves more easily and fully than any of the others to conditions in new localities. Naturally, plants better able than others to alter their properties can make themselves at home in places quite a long way removed from their native parts and differing considerably from the latter as regards climate; and, conversely, plants of more constant character can survive only inconsiderable removals, to localities with a minimum dissimilarity of climatic conditions.

Then, too, you have to take into account that the suitability of seeds for acclimatization purposes depends in no little degree on whether they are taken from fruits of the young plant's first fruiting period or from subsequent ones. The first fruiting always produces the best seeds, the seedlings from which are most likely to adapt themselves to conditions that the plant is not used to; while in succeeding years of fruiting, this valuable property of the seeds dwindles gradually and finally disappears altogether. It is also well to note that there is a certain analogy in the influence which different climatic factors exert on the plants you are training; for example, my experiments and observations have shown that training seedlings in dry air, even though in a much warmer locality, enables the plants to withstand fairly low temperature drops without suffering any harm; that, in fact, dry heat does not make plants delicate, as one might at first assume, while a damp or humid climate, on the contrary, greatly lessens their cold-resistance.

A hybrid seedling from the seed of a tender cultivated apple variety was reared by me for eight years in a very dry lived-in room with central steam heating; there were double windows all the year round, they were never opened, and there were no ventilation panes, and no ventilators generally, except for the door to the next room. Never once in the course of those eight years was my potted seedling taken out into the open. Yet it did not become in the least delicate. Cuttings taken from it and grafted onto the crown of an adult tree in the orchard survive all winters perfectly and take no harm whatever from the frost.

Coming back to the main topic of this article—the assistance that hybridization can render in the acclimatization of plants—I ought to mention, as bearing out my conclusions, that only through the use of hybridization have I lately succeeded in finally overcoming the stubborn resistance that certain foreign varieties offered to acclimatization. For more than a score of years, the Chinese cherry (*Prunus chinensis P.*), *Prunus tomentosa Thbg.*, the Antipka (*Prunus Mahaleb L.*), the quince (*Cydonia vulgaris P.*), a certain hybrid grape (*Vitis riparia Michx.*), the long-flowered lily (*Lilium longiflorum Thbg.*), and many other plants, though reared repeatedly from seeds gathered in my own nursery, adapted themselves but ill to the rigours of our climate; and it was only after they had been crossed artificially with other varieties that the resultant hybrid seedlings showed, beginning with the very first year, a high degree of resistance to winter frost. Quite a large percentage of the seedlings were found to possess this property, particularly in the case of the Chinese cherry and the quince, where the proportion of such specimens was as high as eighty per cent. All I have said relates to species which had not previously been able to endure open-air culture in Central Russia without artificial winter protection; but we observe very nearly the same thing when acclimatizing tender varieties of species many hardy varieties of which have long been grown in our orchards, as, for example, apples, pears, cherries, plums, and so on. True, this cannot in full justice be designated the acclimatization of particular varieties since from planting hybrid seeds one does not, strictly speaking, obtain the varieties from which the seeds are taken, and consequently, this does not constitute the acclimatization of a variety, but rather the breeding of a new variety. But among these new varieties—particularly in the case of stone fruits—some have so many common characters with one of the parent types that it would be no great error, I think, to regard that type as acclimatized and retain its former appellation. To obviate possible pomological confusion, one should add the name of the other crossed variety too, and this is what I have in fact been doing, as witness my names Kandil-Kitaika, Bellefleur-Kitaika, Shafran-Kitaika; or Reine Claude Ternovy, Griotte Stepnoy, and so on. Even such of our local wild plants as the bilberry, the bog bilberry, the mountain cranberry and the cloudberry could by hybridization produce varieties less insistent on an exceptionally damp, boggy soil in order to develop normally. This would enable them to be grown more freely in ordinary garden soil—a thing that has not been achieved so far, although many horticulturists have tried, time and again. For while there

are some so-called improved varieties of these plants, the only qualities man has artificially improved in them are yield and fruit-size; as to cultivation in ordinary garden soil, these improved varieties cannot stand it either.

Of course, we shall not find, among the plants I have just mentioned, strains able to grow in drier soils, which could be used for hybridization; so we shall have to cross some of these plants with their more distant kin; but that will only be in our favour, because seedlings from such crosses always reveal the greatest number of different mutations, out of which it will not be difficult to choose what best suits our ends.

First published in 1913 in
Sadovod i Ogorodnik, No. 24

INFLUENCE OF THE APPLE KITAIKA (*PYRUS PRUNIFOLIA*), WHEN CROSSED WITH CULTIVATED APPLE VARIETIES, UPON THE SIZE, COLOURING AND FLAVOUR OF THE FRUITS OF THE HYBRIDS

It is a big mistake to suppose that the fruits of hybrids from a cross between the apple Kitaika and our cultivated apple varieties will be of a much smaller size than those of the cultivated variety which was taken as a component. Actually, nothing of the kind happens; on the contrary, often the fruits obtained are of a larger size, and even considerably so. Besides, I have invariably observed that in all such hybrids the general yield sharply increases, even quadrupling, and in some cases such excessive fertility is almost a defect of the new variety, as it requires extra care every year to remove the superfluous setting fruit. An essential defect of the hybrids from the Kitaika is the relatively early ripening of the fruits and the reduced ability of the latter to keep fresh for a longer period. But this happens only in approximately 40% of all the hybrid seedlings; consequently, when it is desired to obtain exclusively winter varieties, with the fruits ripening as late as possible in storage, there still remain 60% of the hybrids from which to choose.

Further, in addition to the outstanding property of this apple to transmit to its hybrids its complete hardiness to frosts (of 35° below zero Reaumur and lower), it should also be considered its great merit that when crossed with cultivated apple varieties it never spoils the flavour and the attractive appearance of the fruits in the hybrids. For my part, at any rate, in my numerous observations of various hybrids of the Kitaika, even when I did find defects in the flavour and appearance of the fruits of such hybrids, it was exclusively only in the first years of their fruit bearing; in the subsequent crops these defects gradually disappear without leaving a trace, the fruits acquiring the flavour and beauty of cultivated strains.

To give a graphic idea of the enumerated merits of the Kitaika hybrid as a superior component in the production of new apple varieties, I attach a photographic picture (see Fig. [24]), in natural size, of the fruit of a new

kind of apple, which I call Oleg, and which I described in the magazine *Vestnik Sadovodstva, Plodovodstva i Ogorodnichestva,* No. 4, for 1908, as a Skrizhapel seedling, but when second-generation seedlings from its seed were grown, the phenomenon known as segregation into parent types occurred and a part of these seedlings proved to be typical Kitaikas. Considering the fact that the fruits of Oleg intended for experimental planting set under gauze covers as the result of self-pollination alone, we may safely regard the Oleg not as just a Skrizhapel seedling, but as a hybrid of the latter with the Kitaika. This new variety possesses an amazing power of annual fertility. Its large-sized and pretty fruits literally cover the

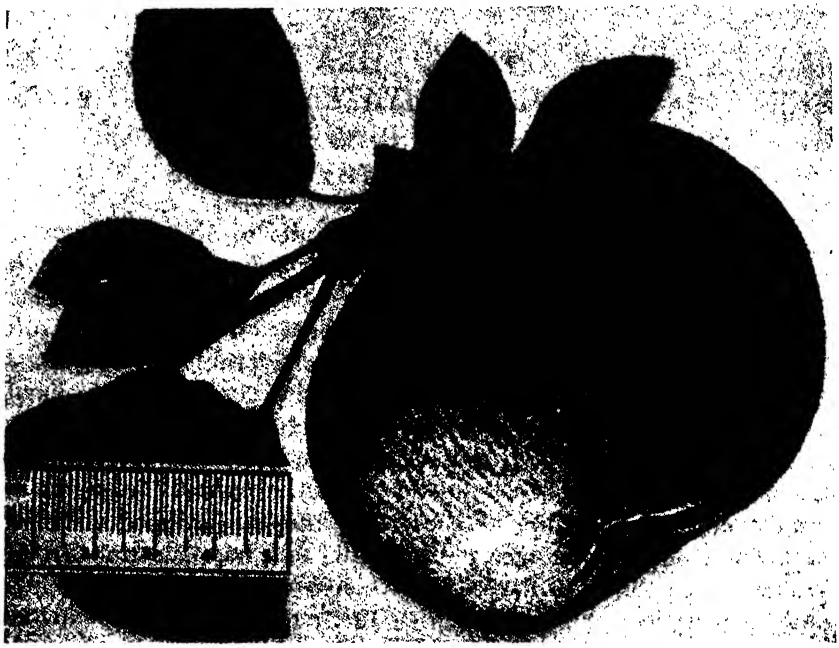


Fig. 24. Oleg—seedling of Skrizhapel; fifth bearing

entire tree and hold fast in strong winds. It is also necessary to take into consideration the fact that the soil in my nursery garden is sandy and meagre, which, obviously, greatly reduces the yields of this excellent strain. Furthermore, in the other new seed varieties obtained by artificially fertilizing the apple Kitaika with the pollen of cultivated strains, for example, Kandil-Kitaika, Kitaiskoye Arkadovoye, Bellefleur-Kitaika, Shafran-Kitaika, Reinette-Kitaika, etc., the participation of the Kitaika is manifested only in good qualities imparted to the hybrids, something that can never be said of our forest apple, whose hybrids sometimes produce fruits of such tart flavour with such a large percentage of astringent tannic substances that even people with the least exacting tastes sometimes refuse to eat them. Besides, the fruits

of hybrids from crosses with the forest apple, in the overwhelming majority of seedlings lose their specific qualities. The basic yellow colouring of the fruits is replaced by an unattractive grey green, the delicate scarlet tint turns into a dirty brown, etc. . . . Furthermore, the forest apple never produces such fertile hybrids as the Kitaika. It may be suggested, of course, that in my work on crosses I have hit exclusively on unsuitable varieties of the forest apple, even despite the fact that I have used many different ones; it is possible that among forest apples, too, specimens will be found which are more suitable for hybridization. Nevertheless, I doubt whether it is possible to find among them a variety which could possess so many good qualities for the production of new orchard strains of apples as the Kitaika.

Without in the least exaggerating, I must say the same, if not more, also of the influence of components from the Siberian crab apple. Whatever the various upholders of the Siberian crab may say, it produces hybrids of extremely poor quality not only in sexual union, when crossed with our cultivated varieties, but also when employed purely vegetatively, as a stock, it lowers the quality of the fruits of the varieties grafted upon it. This becomes particularly obvious when the variety grafted upon the Siberian crab apple is not an old, long-established one, but a young one, recently bred from seed. The upholders of the usefulness of grafting apples in our parts upon the Siberian crab apple say that the defects of this stock, noticed by some horticulturists, cannot serve as proof that the Siberian crab apple is unsuitable for this purpose, because, they argue, there exist many natural varieties of this species of apple, some of which may, indeed, be unsuitable as stock, whereas others may prove to be quite suitable for the purpose. All this may be so. But, in the first place, we are to this day unable to tell which varieties of the Siberian apple are suitable, and which are not suitable, for use as stock in our regions, nor can we tell exactly for which strains some varieties are suitable and others are not. Secondly, we should regard as utterly useless, if not worse, all the efforts of some horticulturists to introduce in the regions of Central Russia a stock of doubtful quality, when we have at hand a stock so universal in its qualities and tested for so long a time as the Kitaika of our orchards. Better may sometimes prove the enemy of good. At least, *we in the central belt of Russia, need search for no better stock than the Kitaika for apple culture in the full-stem and half-stem forms.* At the extreme northern boundary accessible to apple culture, on low cold soils, a stock from the Siberian apple may, perhaps, prove to be suitable, but this still has to be clarified on the spot by long experiment. It is further asserted that it is only thanks to the use of this stock alone that we have in the orchards of Central Russia such splendid varieties as, for example, Snowy Calville, Bellefleur, Golden Pearmain, etc. Don't let such a fortuitous and evanescent mirage deceive you, gentlemen: all these and similar delicate southern strains cannot be established in our regions by such means. They may at first, perhaps, go on existing for a decade or even two, during which time they may give two or three strikingly big crops, but at the same time they will be suffering and gradually becoming enfeebled as the result of the unsuitable climatic condi-

tions, they will in the end prove unequal to them and inevitably perish in one of our rigorous winters. Of course, in such cases you, gentlemen, will blame the particular severity of the winter. But that will be extremely unfair. The winter with its frosts is not to blame for this, it must not be regarded as a scourge of our horticulturists; on the contrary, our sharp frost is a just inspector, a capable, diligent and up-to-the-mark sorter in our gardens, a patient, attentive, all-sided teacher and instructor of horticulturists, and at the same time an unbiassed judge of their knowledge, skill, industry and attention to his instructions and lessons. Yet it is upon this inspector and teacher that from times immemorial people are in the habit of blaming every fault of theirs, always complaining against him because he follows a course according to programs and plans which not they have established, eternally scheming and designing against the judge who passes sentence and judgment not in accordance with man-made and man-confirmed laws. Is this right, gentlemen? I believe that we are far from being right in our complaints against the actions of Nature. We ought not to complain against her, but patiently learn from her, endeavouring to rectify our mistakes in accordance with her laws.

It is always possible to achieve the acclimatization of plants by natural ways, by sexual propagation, with the application of crossing with our local varieties. But from combinations such as with the hardy stock of the Siberian apple, which has for ages become adapted to existence in the Siberian taiga, where during the whole year the soil is never thawed out more than one arshin in depth, nothing but harm can come to the orchards of the central regions of Russia.

First published in 1913 in
Progressivnoye Sadovodstvo i Ogorodnichestvo, No. 36

ON THE INAPPLICABILITY OF MENDEL'S LAWS TO HYBRIDIZATION

In this paper I shall lay forth a number of facts obtained from the hybridization of fruit plants that indisputably prove the perfect inadequacy of the notorious Mendel's law when applied to hybrids of perennial fruiters.

In my article, "The Production of New Varieties of Fruit Trees Grown from Seed," dating five years back I already wrote, that, according to my many years' experience in this field, in artificial crosses between different varieties of fruit trees practically in all cases it is impossible to count on obtaining young hybrid plants with certain definite properties, to say nothing of the absolute impossibility of making any reliable preliminary estimates for the second or third generations in respect to the proportion of seedlings that might deviate in their type towards one or the other of the parents.

Mendel's conclusions drawn from his experiments on the crossing of two chosen varieties of peas, as well as those of his followers, who effected

crosses between different varieties of stinging nettles, barley, maize, etc., could be only accidentally correct; these conclusions would be true only if the same varieties of the above-mentioned plants were used in the crosses and if there were no sharp environmental changes affecting the development of both the parent plants and the hybrid seedlings derived from them. Such accidentally suitable combinations may likewise occur in crosses between fruit trees and, in fact, in any other species of plants; but all cases of this type can be of any importance only to complete dilettantes in plant hybridization. For an experienced hybridizer, however, such phenomena are of no significance whatsoever. The point is, that, besides the influence of such a factor as the hereditary transmission to the progeny of their distinctive features, or to be more precise, their properties, by the parent plants (which is in itself a variable process) the formation of the hybrid seedling's constitution may be considerably affected by a large number of various other factors, some of which in their action may be absolutely imperceptible to man, whereas the action of other factors, it is sometimes not in his power to eliminate. Of prime importance among such factors are, in the first place, the climatic conditions during the vegetation period in which all such processes, as the fertilization, the setting and the maturing of the fruit obtained from the cross take place. Here comes into play the complex effect of physical factors, such as the atmospheric pressure, the temperature conditions, the amount of moisture, the intensity of the sunlight and the activity of the atmospheric electricity; the separate effects of each of these factors as well as the combined effects rendered by their various combinations are capable of inducing significant changes in the structure of the germ plasm, as well as of affecting the development of seeds in the hybrid fruit; furthermore, the formation of the hybrid seedling's constitution during the first few years of its life span, besides being affected by the factors already mentioned, is influenced also by many other factors, such as the accidental even though only partial damage of seeds due to overdrying, the composition of the soil, the character of the site, etc.

It seems to me that all of our Mendelists are disinclined to take into account the powerful influence of these factors on the development of the hybrid plant, beginning with the formation of the seed from the cross of two individuals and continuing during the first years of growth of the young seedling right up to the stage of maturity. As a matter of fact, numerous observations demonstrate that not only the hybrid seed itself is capable of deviating in the development of its germ cell in the direction of one or the other parental plant in response to the action of the above-mentioned environmental factors, but also the hybrid seedling grown from that seed during the entire growth period up to the stage of maturity and the ultimate stability and invariability of its characters is subject to repeated deviations towards one or the other parental type, depending upon the various environmental factors. The following fact may serve as an example: I pollinated the flowers of *Pyrus elaeagnifolia* with the pollen of a well-known orchard variety of pear named Bessemyanka [Seedless].

Fruit and leaves of the pure species *Pyrus elaeagnifolia* are shown in the centre of Fig. [9]. A leaf of the Bessemyanka pear is shown in the left upper corner of the figure, while a leaf of the hybrid produced by a cross between these parental forms is shown on the right. When rearing the seedlings of all the three forms I observed that whenever they were given better nourishment externally in all their parts the hybrid seedlings invariably deviated towards the Bessemyanka type. The leaf blades became broader and had a glossy surface, the shoots became thicker and their bark acquired a colour resembling that of the shoots of Bessemyanka. On the other hand, if the seedlings were subjected to some hardship, such as replanting or the insufficient water supply in the beginning of the vegetation period due to summer drought, the leaves of the hybrid plants grew narrow and elongated in shape, their surface as well as the bark of the shoots became downy, the buds became more rounded, in a word, all the elements of their habit showed a distinct trend towards the maternal type of *Pyrus elaeagnifolia* (the hybrids did not bear any fruit as yet).

Similar phenomena have been recorded in hybrids from other crosses as well, whenever a cultivated variety was crossed to a wild species. When a cross was made between two different varieties belonging to the same species, lack of nutrition or a drought usually caused deviation of the hybrids towards the type of the older parental variety—the one of longer standing. I have also carried out numerous other experiments to determine the effect of the composition of the soil on the constitution of growing hybrid plants and each time I became convinced of the considerable influence exerted by this factor. This influence was particularly pronounced in those cases when I succeeded in providing for the hybrid seedlings such a soil that was closely similar in composition to that on which one of the two parental plant varieties involved in the cross had successfully developed for a long period of time, or, so to say, had been formed, whereas the type of the other parent had been developed on a soil of an entirely different composition. In almost all such cases the hybrid seedlings were observed to resemble in type the first parent. Thus, I used to order several poods of soil to be brought from the environs of Vladimir to grow the hybrids obtained in crosses between one of our cherry varieties raised in the Samara steppe region (*Prunus Chamaecerasus*) and the Roditeleva cherry from Vladimir. The soil ordered was the very one on which the Roditeleva cherry—a well-known Vladimir variety of cherries—was grown in its native locality. Although by means of this substitution of soil I succeeded only in partly approximating the environmental conditions in which these hybrids were reared to those of the Roditeleva cherry's native habitat, nevertheless the few specimens of hybrid seedlings that were given a mixed soil containing a high proportion of the Vladimir soil, showed a pronounced trend towards the Roditeleva cherry and markedly differed from the rest of the seedlings brought up on the ordinary soil of our locality. And just to think that this result has been obtained in experiments, in which so many necessary conditions were missing! These hybrid seedlings ought really to have been planted in Vladimir, not in Kozlov, and

grown in the native locality of the Roditeleva cherry, because (besides soil composition) other factors such as the composition of the subsoil, and of the subsoil water, the depth of the subsoil water table level, the lay of the site, the difference in the climatic conditions, etc., play an important role. And if even in the absence of the influence of these important factors the supplying of the native soil alone was enough to produce so marked a deviation towards one of the parental types, then how is it possible to make correct estimates of the proportion of plants in a hybrid progeny that would deviate towards one or the other parental type and of the degree of this deviation merely on the basis of the hereditary transmission of the latter's properties.

In addition to all that was said above attention must be likewise called to the fact that in the various mating combinations the individual potency of transmitting hereditary factors in any given plant is in itself subject to considerable variation. Thus, let us assume that in a cross of the plant *A* with the plant *B* the former transmits its characters to a greater number of the hybrids and of their second-generation seedlings, while the characters of *B* were not manifested either in the hybrids or in the hybrid seedlings of the second generation. Now in the crosses involving some different combinations of mates, say those of the plant *A* with the plants *B* or *C*, the characters of plant *A* may not be manifested at all either in the hybrids or in their seedling progeny. In such cases the accepted view is that these characters are present in hybrids in a recessive state, and that they do not vanish altogether. This conception is not always true: it is possible that in some cases the characters that are not manifested were entirely obliterated by the diametrically opposite action of the characters of the plant *B* which are dominant in the cross with this particular mate.

Furthermore, in crosses between certain plants entirely new characters sometimes appear among the first-generation hybrids or among the hybrid seedlings of the second and the third generations, characters that had never occurred either in the paired parent plants or in their nearest ancestors. In this case, too, the suggestion that such characters must have already existed in some inactive or latent state either in the plants paired or in their ancestors cannot be regarded as being always true. Of course, in some instances this might be the case, but there is a possibility of these new characters having originated anew as a result of a favourable for their development combined effect of the hereditary factors obtained from the two different parent plants.

This can be illustrated by the following instance of such a phenomenon:

I have crossed *Lilium Szovitsianum* to *Lilium Thunbergianum*, the yellow flowers of the first having been pollinated by the pollen collected from the scarlet flowers of the latter. The several hundred hybrid specimens both of the first and of the second generation derived from this cross were plants that could hardly be distinguished from *Lilium Szovitsianum*. They had leaves of the same shape as those of *L. Szovitsianum*, the arrangement of the leaves on the stem was the same, and the flowers were the same—yellow and somewhat drooping, the only differences observable in but a few second-generation individuals being a somewhat darker colour of the anthers and

the almost doubled height of the specimens as compared to *L. Szovitsianum* plants. The third hybrid generation obtained by selfing on the whole was like the first two generations with the exception of a few individuals that showed various deviations. The most notable among these was a specimen that had a unique and a quite new flower colour. Its flowers had a glossy, bright purple colour that later gradually changed to a light-brown tint. The anthers and the pollen were black, which is absolutely unusual in the *Liliaceae* family; the fragrance of the flowers resembled very much that of orchids; for this reason I have given this new variety the name of Fialkovaya Lilia [Orchid Lily]. Besides, it was found on replanting the bulb of this lily that there was an umbellate compact collar encircling the stem at the level of the upper border line of the bulb segments formed by accrete adventitious stem-roots. This collar offered a splendid protection for the bulb against rainwater and extraneous bodies getting inside. This umbrella being closely contiguous to the upper ends of the external surface of the bulb scales is of especial value as a protective screen preventing the penetration into the bulb of insect pests that usually creep down the stalk and thus get into the bulb where they deposit their eggs. The larvae of these insects in most cases cause great damage to the bulbs resulting in their rotting and subsequent rapid death. It is relevant to mention in this connection that many other lily species also possess adventitious roots in the lower part of the stem. These roots, however, usually do not form a regular collar encircling the stem, but are haphazardly placed at several different levels and besides, they never fuse together to form a compact umbellate collar covering the bulb. In the above instance a simultaneous appearance of four new characters was thus observed in the new Fialkovaya Lilia variety, namely, the purple colour of the flowers, black anthers, the fragrance of orchids and the umbellate collar formed by adventitious roots. It is a noteworthy fact in this connection that neither one of the parent plants nor any of their nearest known ancestors possessed any of those characters, and I consider the assumption of existence in these ancestors of some latent tendency to produce such characters as hardly plausible in this case, because it might be assumed with equal success that there had been no such tendency whatever; the appearance of the new characters may have been simply the result of a random occurrence of some particular combination of environmental factors that in their joint effect proved capable of producing them. It is especially hard to conceive that there had existed in the parental forms such a dormant tendency for the development of the last of the characters described, namely, the compact umbellate collar protective for the bulb and formed by adventitious roots. Such a mutation might be regarded either as having been produced by a sheer chance or, more probably, as having been brought forth by the sound potency for adaptation inherent in every living organism in its fight for existence. And, finally, even if the possibility that environmental factors played a part in the production of the new characters be excluded and if their origin be ascribed solely to some pre-existing in parental forms latent tendencies to produce new characters in their hybrid

progeny, then the inapplicability of Mendel's law becomes all the more obvious for the simple reason, if for no other, that no hybridizer can ever possibly know beforehand what particular latent tendencies are inherent in the parental forms; besides, it cannot be predicted in what particular combinations of the two parental hereditary influences would a particular trend towards one or the other parental type be produced in the constitution of the hybrid.

First published in 1915 in
Sadovod, No. 5

USE OF MENTORS IN TRAINING HYBRID SEEDLINGS AND INSTANCES OF PRONOUNCED CHANGES OCCASIONED IN FRUIT VARIETIES BY VARIOUS OUTSIDE FACTORS[1]

In this article I should like to communicate some rather interesting observations made in the breeding of new fruit-tree varieties. First of all, I want to indicate here how greatly a young variety can change under the combined influence of an adult wild stock and a climate too cold for the variety to bear. The example I quote to illustrate this also shows, incidentally, that fruit buds are not always less frost-resistant than the other parts of the tree, notwithstanding the statements altogether to the contrary which may be found in our horticultural publications.

Secondly, careful observation reveals that this change in a variety is not equally marked in all parts of the plant. For example, in some cases the size of the fruit diminishes considerably, its shape changes, but the texture and taste of the flesh and the property of keeping far into the winter may remain unaltered; or the other way round. Next, the hardiness of some parts of a plant diminishes, while other, more tender parts, on the contrary, become more cold-resistant. In a word, the infinite diversity of constitution in such vegetative hybrids results from the combined influence of inherent and outside factors—almost exactly as in the case of sexual hybrids raised from seed. The number of different factors which may alter the constitution of a variety—whether a vegetative or a sexual hybrid—is so great, and the modes of their influence are so varied, that it is quite impossible to find one's way in this maze and foretell in advance what will be the result of their combined operation. Most of the expectations built on theoretical deductions in this matter are not borne out in practice. As to applying Mendel's notorious pea laws in breeding new hybrid varieties of perennial fruiters, only complete ignoramuses in this work can dream of that. Not only are Mendel's conclusions not borne out in crosses of perennial fruiters; but in the case of annuals too—for example, even in vegetables—crosses of other varieties and species, in places with other climatic conditions, produce results very different from Mendel's. In all the observations I have made in the course of my forty years

[1] Not published in I. V. Michurin's lifetime.—*Ed.*

work on hybridization, I have invariably seen the following. That the constitution of every hybrid depends altogether, firstly, upon the individual potency of the respective parent types in transmitting one or another of their characters to the progeny; secondly, that the interaction between the two parent types takes place in different combinations, in which the manifestation in the hybrids of some property of one parent may be intensified or may be totally nullified by the influence of the other parent. Let me quote an example in illustration. In an effort to breed a new pear variety hardy for Central Russia, with good flavour and winter-keeping qualities, I several times crossed well-known foreign winter pears—Beurré Diel, Beurré Clairgeau, Liegel's Beurré, Saint-Germain and others—with our local varieties —Tonkovetka, Tsarskaya and Bessemyanka; from the resultant hybrids I obtained several good and hardy new types, but all of them had fruits ripening early, in the summer, and unable to keep in the winter. Clearly, the combinations I took for crossing were such that the keeping qualities of the foreign winter pears could not manifest themselves in the hybrids, they were paralyzed by the more vigorous influence of our early-ripening local pears. Nor was this desired property to be found in second-generation seedlings raised from the seeds of these hybrids. The expected segregation into parent types did not occur in them; on the contrary, all the second-generation seedlings deviated still more in the direction of our local pear varieties, and there was nothing at all remarkable about their qualities. But just recently, I have at last succeeded in finding a suitable parent for crossing with foreign winter pears—a type whose influence does not prevent the hybrids from having the qualities we desire. I crossed Beurré Diel with a young seedling of the Ussurian wild pear, in its first flowering. Out of the resultant hybrids, two-thirds proved to be summer and autumn ripeners, but one-third had fruit that matured in the winter; and of this third, one hybrid in particular was a remarkably happy combination of the properties of the two parent types. From the Ussurian pear it inherited complete hardiness against our frosts, while from Beurré Diel it got large size of the fruits, their fine dessert flavour, and, most valuable of all, their ability to keep until midwinter. Thus we obtained a genuine winter dessert pear variety unrivalled in value in our orchards, which I named Michurin Beurré Zimnaya (see Fig. [25]). It can be said without exaggeration that, planted in our orchards, this variety will effect a complete revolution in our fruit growing, increasing the returns from our orchards to more than five times the highest present rate.

Another example. Among the small Siberian crab-apple seedlings in my nursery, there is one which produces, even before the autumn frosts set in, fruit with flesh of a liquescent consistency. I naturally felt I should like to secure, by crossing this Siberian crab variety with our large-fruited cultivated types, a new type that would yield large fruits with a good flavour and a liquescent flesh. An apple variety like that would really be something quite out of the ordinary. But unfortunately I have not up to the present been able to accomplish this. The fruits of the hybrids produced by various crosses were not liquescent. However, this failure cannot be taken as a sign that it is

altogether impossible to obtain a hybrid with liquescent fruits. It must be due only to my having failed to find the right combination of parents. Apparently, the cultivated varieties which were crossed with the Siberian crab had characters in the presence of which the desired property of the Siberian crab could not manifest itself in the hybrids; no doubt, given a happier choice of variety for crossing, we shall be quite able to gain our point. It is possible, of course, that to breed such a type, the hybrids will have to be trained under somewhat unusual conditions, with a different composition and

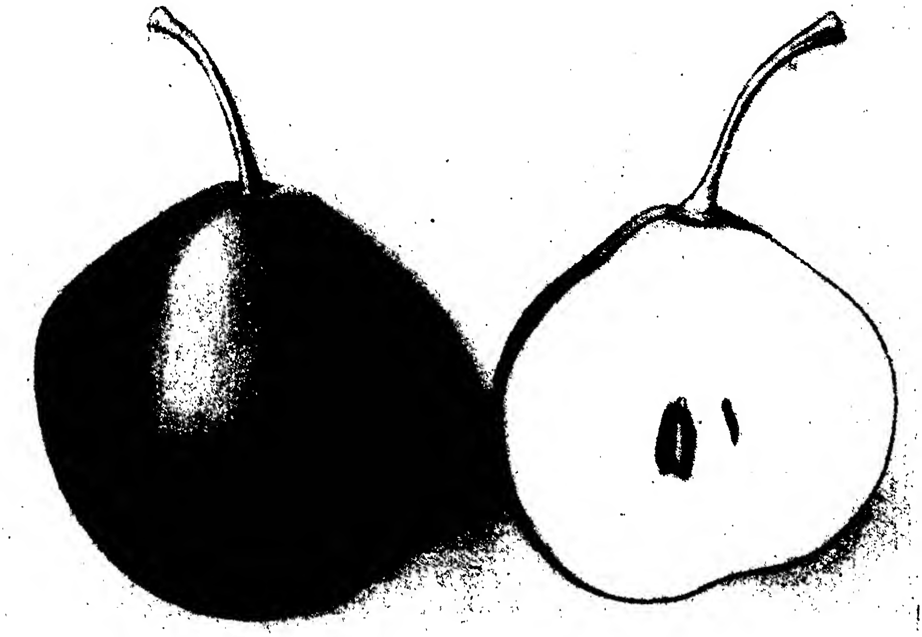


Fig. 25. Michurin Beurré Zimnaya (from I. V. Michurin's archives). Reduced

moisture content of the soil, as these factors always have a very strong influence on the constitution of young hybrid organisms. In mentioning these unsuccessful experiments, I must remark in passing on the Siberian crab's high degree of stability in the hereditary transmission of its properties to hybrids. Nearly all the seedlings I raised from these crosses produced very small sour fruits differing from one another only as to colouring and shape. And only one hybrid seedling, obtained by crossing the liquescent Siberian crab with the large-fruited cultivated Kandil-Kitaika, was remarkable for its extremely early fruiting—in its fifth year—and for its uncommonly generous crops.

Even one-year-old buddings of this hybrid flower and bear fruit, one and all; but the fruits are not large, no larger than the common Kitaika; they are

of elongated oval shape and bright carmine colour, and have a juicy tartish flesh of indifferent flavour. Some of the fruits bear the distinctive characteristic of the small Siberian crab—the deciduous calyx. This variety can be of value for culture in cold regions, beyond the northernmost cultivation boundary of orchard apple varieties, where one- and two-year-old buddings of it will endure very severe winter frosts without difficulty given the protection of snow. It can also be of considerable use in fruit growing in our own parts, since it provides good material for intermediate grafting in the training of apple trees for form. Lastly, it is invaluable as a mentor for hastening the onset of fruiting in new hybrid apple varieties. Let me acquaint the reader in passing with a new and very interesting method I have devised, which makes it possible for the characters and properties of young hybrid fruit-tree seedlings to be partially altered at the originator's will—for seedlings to be trained, so to speak, in the direction we desire, so that their good qualities are accentuated and built up, while their tendency to develop bad, undesirable qualities is checked or even totally eliminated. Perhaps the reader, and particularly the learned horticulturist, will at first think my method improbable, especially as it has not been invented by some foreign professor of botany, but by a native Russian orchardman, and not on the basis of learned theoretical deductions, but solely of practical experiments and constant observation in the course of many years spent in breeding new fruit varieties. Fortunately, however, such doubts will not do any harm, but, on the contrary, will help towards a fuller elucidation of this method and more comprehensive elaboration of its details. In any case, I make bold to assure you, gentlemen, that in the first properly-conducted experiment to test my method, results corroborating it will not be long in coming. This method is as follows. Suppose we have a well-developed six- or seven-year-old hybrid seedling which is not yet bearing, and we know that, unless measures of compulsion are taken, we shall have to wait another ten years or so for its first fruiting, as one does with hybrids among whose progenitors are varieties that perhaps reach fruiting age only in their twentieth year. Well, if we take three or four cuttings from a definitely high-yielding variety of fruiter, and graft them onto the lower branches of this seedling's crown, not far from the trunk, our seedling will, under the influence of this mentor, bear fruit within the next two years. After this the mentor scions must be cut out, otherwise the mentor variety's influence may also affect the hybrid's fruit qualities, and in the course of succeeding years this change may become permanently fixed in the new variety, which, of course, may not always be desirable. If, on the contrary, the mentor variety has properties which it would be useful to impart to the fruits of the hybrid, let us leave the scions to develop and bear fruit together with the hybrid during their first three or four bearing years. This is quite long enough for the changes introduced by the mentor to become fixed in the new variety. I have made several experiments to test the effectiveness of this method in hastening the onset of fruiting in hybrid seedlings, and the results were good each time. Then, in several (three) cases, I used this method to improve the qualities of the hybrid fruit, build up its winter keep-

ing qualities, improve the colouring and raise the sugar content of the flesh—and in these cases the mentors were supplied after the hybrids had already fruited for the first time. Lastly, in two cases the method was used with complete success to increase a new variety's frost resistance. Still, it cannot be said that every time I employed this method, the result was a success. Exceptions also occurred. For example, I failed altogether to eliminate by this means the undesirable traits of the hybrid from a cross between Antonovka and White Winter Calville. The fruits of this hybrid, while of very good flavour, are of unprepossessing appearance, and so ill attached to the branches that the first strong gust of wind brings practically all of them down from the tree in the middle of the summer. Whether the influence of the mentor varieties was insufficiently strong, or whether it was too late and this shortcoming of the new variety had already become fixed—in any case, all my efforts over a period of six years to eliminate it failed to achieve their purpose. From all I have said it should be seen that the uses of the mentor method are not confined only to accelerating the onset of fruiting. Clearly, this method can also be employed to induce many other changes in the traits and properties of hybrid varieties, for example, to increase yield and fruit-size, give the fruits a more vivid colouring and better winter keeping qualities, secure a higher sugar content in the flesh, make the tree more frost-resistant, and so on. In a word, when the details of this method and its uses in breeding new varieties have been fully worked out, we shall at last have made a big step towards achieving the long-desired control over the process, without which the results of our work have for the greater part been dependent on various accidental outside factors whose influence we were totally unable to lessen or eliminate, so that we had to content ourselves with only such qualities in our new varieties as fate chose to send us. That being the case, much labour was wasted, and practically ninety-five per cent of all the hybrid seedlings raised had to be destroyed by reason of one or another shortcoming. I must remind the reader again that the method I recommend can be employed effectively only on young seedlings growing on their own roots, and exclusively hybrid ones, what is more—and not on such as have been grafted onto wildings, nor on old, long-established varieties.

Let me quote some instances to illustrate the uses made of mentors in my nursery (I select cases where the changes were most pronounced).

1. As long ago as 1904, we took one of two choice, not yet bearing eight-year-old seedlings of the large-fruited Sapezhanka pear, and grafted some cuttings of the Malikovka or Moldavskaya Krasnaya pear onto the lower branches near the trunk as a mentor to induce fruiting. In 1906 this mentored seedling bore its first fruits (see Fig. 2[1]), which had a delicious flavour and ripened very early (by July 15). The following year, that is, in 1907, fruiting also set in on the limbs of the mentor scions, which have not been removed from the tree to this day. Under the influence of this mentor—the late,

[1] Fig. 2 and all subsequent ones not discovered in the Michurin archives.—*Ed.*

autumn-ripening, oblong-fruited Malikovka—the fruit of the young Sapezhanka seedling gradually changed its shape (by the seventh crop in 1912) to a more oblong one, and its period of ripening became delayed until the latter half of August, while its flavour remained unaltered. This new variety, which I have named Bergamotte Novik, is described in detail, with photograph appended, in the *Vestnik Sadovodstva, Plodovodstva i Ogorodnichestva* for 1907. As to the other Sapezhanka seedling, which had no mentor, it has not started fruiting to this day, though already twenty years old. I should like to point out that in this instance the mentor was beneficial because it accelerated fruiting, but that by its continued influence it deprived the new variety of the exceedingly valuable property of early maturation; this was positively harmful, because the earliest-ripening fruits fetch much higher prices than those ripening at the usual season, when there are many other kinds of pears in the market. So it would have been more expedient to cut out the mentors at a judicious moment—in the early summer of the seedling's first fruiting year.

Fig. 26. Moldavskaya Krasnaya pear (from I. V. Michurin's archives)

2. From the new Bergamotte Novik pear which I have just described, cuttings were taken in its first fruiting year and grafted onto branches in the crown of an adult and already bearing wild pear tree. In the course of the next five years, all the wild branches were gradually cut out. In the sixth year after the graft, the tree bore its first fruits, but these had nothing in common with Bergamotte Novik as regards size and shape, they differed hardly at all from the fruits of the wild pear and only their flavour was slightly better. Here the retrogression of the young variety was, of course, due to the adverse mentor action of the wild pear stock, which, being old, possessed greater vigour of influence. In my nursery I have several times had occasion to observe such undesirable consequences of ill-advisedly grafting a young variety onto an old wild stock. From this instructive example the reader can see, in the first place, that one should not be in too great a

hurry to propagate each new variety in the first few years after it appears, particularly by grafting it onto the trunks of wild stocks; secondly, it follows that one cannot implicitly believe all the advice given even by the best-known learned horticultural authorities, especially as these gentlemen often found their advice solely on theoretical deductions, on armchair hypotheses and not on practical experiment. They frequently make up their minds on the basis of analogy alone, assuming that if old fruit varieties can be grafted onto wildings of all ages without having their qualities impaired by the adverse influence of the stock, then the same thing can be done with young varieties.

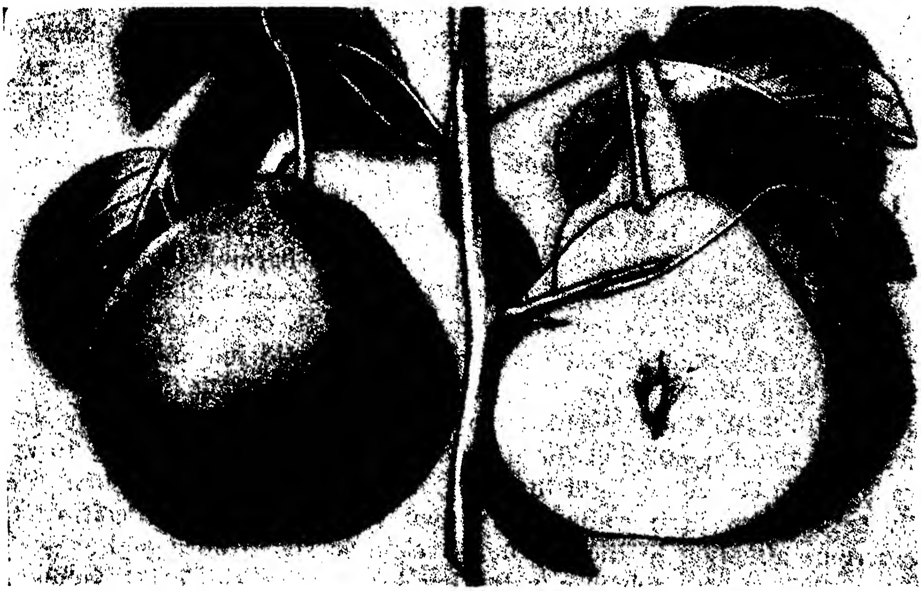


Fig. 27. Bergamotte Novik (from I. V. Michurin's archives). Reduced

This erroneous deduction is responsible for the advice they give, that "to accelerate fruiting in hybrid seedlings, they should be grafted onto the crowns of adults of wild species or old cultivated varieties." Many readers will no doubt have met with such advice in the press. Yet the fact is that this should never be done, and in general cuttings for grafting should not be taken from a seedling before it has fruited three times. At subsequent fruitings—the fourth, fifth, sixth, and up to the tenth—the new variety may be budded, but only onto young one- and two-year-old stocks; and only thereafter, roughly speaking, may one venture to graft it onto the crowns of adult stocks. If this is not observed and the grafts are made too early, what you get on most of the old trees onto whose crowns you make them is not the variety you raised from seed, but only a vegetative hybrid of it with the variety of the stock. And so if a young seed-grown variety is grafted, before it reaches maturity, onto the crown of an adult of a wild species, nothing can be ex-

pected to come of it but complete spoilage of this new variety, except in the very infrequent cases when it is found expedient to sacrifice some of the good traits of the new seedling variety in order to accentuate or newly introduce some character by resorting to the influence of the wild stock. For example, a cross of the well-known Crimean Kandil Sinap apple with Kitaika yielded seedlings that were insufficiently hardy against our frosts; and so, in order to increase hardiness to the desired degree, I took some twigs from the seedling of best outward appearance and grafted them onto the crown of the maternal Kitaika tree. Knowing the good flavour of this Kitaika, I was risking very little—only a possible reduction in fruit size; in return I hoped to make the new variety an abundant cropper, and completely proof against frost—without which the seedlings would have had to be destroyed. My expectations were vindicated, and in this way I obtained a new hardy variety with excellent fruits, which I named Kandil-Kitaika. (A description of it, with a photograph of the fruit, may be found in the *Vestnik Sadovodstva* for 1907.[1])

As to cases when useful results can be expected from making an early graft of a young variety onto the crown of an adult of a good cultivated type, it has to be said that they too are rather rare. In the majority of cases, such grafts can do as much and sometimes even more harm than grafting onto the crown of an adult wilding. I myself have at various times been faced with such bad and, moreover, totally unexpected effects upon the properties of young varieties that at first I was positively bewildered and quite unable to explain such deterioration. Only afterwards, by grafting the new variety onto a wild offshoot of the selfsame cultivated tree, did I succeed in solving this puzzle. It turns out that the deterioration of the young variety in such cases is due to the influence of the wild stock on which the adult tree of the cultivated type has been grafted and grown. I would advise horticulturists to give serious attention to the enormous scientific significance of this fact—that the stock of an adult tree which has long borne fruit exerts influence, even through large intermediate portions of the earlier-grafted cultivated variety, upon a young, not yet change-resistant variety newly grafted on the crown.

From this it may be seen that, even after the wild stock has been subjected for a long time to the influence of the variety grafted upon it, its individual properties still retain much of their force; and as soon as portions of a still unstabilized young plant appear in their sphere of action—whether in the initial development stage, as *hybrid seeds* resulting from fertilization with another variety, or at an older age, as grafted cuttings—these properties of the stock invariably obtrude themselves upon the young plant and change its constitution for the worse. That, too, is largely the reason why the overwhelming majority of hybrid seedlings, sometimes as high a proportion as ninety-five per cent, have undesirable wild properties. Whenever rules are given in horticultural literature for hybridizing cultivated fruit-tree varieties, we are told that the large number of wildings among hybrid seedlings is due

[1] Pp. 293-97 in this volume.—*Ed.*

entirely to atavism, that is, to an absolutely incurable tendency of all seedlings to revert in form to their remote ancestors. Although the influence of the stock has long been generally recognized, not a word is breathed about it, and its operation in these cases is, as it were, totally denied. But in hybridization of fruiters, horticulturists have to deal almost exclusively with grafted trees, and therefore they must necessarily encounter and reckon with this indisputable influence, which is, actually, immeasurably greater than that of atavism. For when we take a grafted tree of some variety as the maternal parent in a cross, and of the resultant seedlings only a negligible proportion bear the characters of the parent types, while the majority are simply wildings, the cause is not atavism at all, but almost exclusively the very strong and stable influence of the maternal plant's old stock upon the extremely weak and unstabilized constitution of the hybrid seeds. In other words, what we get is vegetative hybrids of the wild stock, with only the most negligible admixture of the properties of the cultivated varieties. Now let readers judge for themselves whether one can in such cases apply the vaunted pea laws of Mendel, in which this Austrian monk, on the basis of the observations he made in crossing two varieties of peas, determines in advance the number of hybrids that must deviate in their constitution towards the one and the other of the parent plants. I repeat that only the completest ignoramuses in the hybridization of fruit trees can dream of applying to it conclusions obtained by observations made on peas.

And yet we often meet in the press various pronouncements, mostly from the pens of learned horticultural theoreticians, about the suitability of doing this. Many of these gentlemen are evidently misled by the fact that when old orchard fruit varieties are propagated in the usual way by grafting, they hardly change at all under the influence of the wild stock. On this basis many imagine that, in general, the stock cannot influence any variety grafted onto it, even if that variety is a young one. But actually this conclusion is utterly incorrect. For in the first of these cases, an old variety with long-established and fixed properties is grafted onto a wild stock which is younger than itself and whose influence accordingly is not able to change it. But in the second case everything is just the other way round. Here a young variety, in the earliest stage of its development, falls under the potent influence of an old wild stock, and, being weak, it of course succumbs completely and deviates almost entirely in the direction of the wilding. Unfortunately, not only do we find no indication of what I have just said in authoritative scientific articles by Russian and foreign writers in our field, but, on the contrary, the authors of such articles and pamphlets, as, for example, Baur, Strassburger and Max Löbner, almost entirely deny the importance of grafted hybrids for the horticulturist. But here you have to consider that many of these researchers conducted their experiments and observations almost exclusively with herbaceous plants—even if perennial ones—whose complete cycle of development probably did not exceed two years and the very constitution of which differs too much from that of fruit trees, so that experiments conducted with them could not have any relevance to our experiments with

fruit trees. As to the experiments and observations made by Lindemuth, Adam and others on shrubs, which come somewhat closer to our own work, these too were not complete or systematic enough to make their results of any value for us; particularly as the various fragmentary communications to be found in the press about the work of these foreign researchers lack sufficient fullness and clarity, and are evidently not quite accurate in most cases, and not infrequently contradictory. Now as to certain pamphlets published in Russian, such as Max Löbner's *Fundamentals of Breeding Garden Plants*, which appeared as a supplement to the *Sad i Ogorod*. From this pamphlet it is quite obvious that Mr. Löbner wrote it not on the basis of his own observations, but of material collected here and there about the work done in this field by other people. As for himself, if he did make a few experiments, it was solely with annual flower plants. Hence his frequent erroneous conclusions and the considerable omissions in his chapters on fruit plants. In general, such compilers of data, some of whom are in effect pretty ignorant of the subject, for the most part muddle the exposition, present certain particulars of the work in a false light and crown the whole with incongruous fancies of their own, founded on nothing but analogy. And despite all the contrary opinions of foreign researchers who do not recognize the influence of the stock, I emphatically declare, on the basis of my many years' work, that this influence does exist and that, in breeding new fruit varieties, the horticulturist must needs take serious note of it. In view of this, the propagation of young new fruit varieties by grafting of any kind before they have fruited for about five or six years may be attempted only if one has a thorough knowledge of how the stock should be chosen; otherwise you are bound to ruin the young variety. I therefore think it well to offer some advice, based on my own frequently repeated experiments, as to the best kinds of stock to choose. If it is desired at all costs to have adult specimens of the new varieties at an early date, the procedure involving least risk is to make grafts onto the crowns of adult own-rooted trees of cultivated types; if these are not available, one may use for apples seven- or eight-year-old orchard Kitaika seedlings which have just begun to fruit, and similar seedlings of local cultivated varieties. Best suited for pears in such cases are quince seedlings,[1] Gleck seedlings and young trees raised from the seeds of old Bergamotte varieties. Young two- or one-year-old stocks, excepting only the stablest wild forest species—such as the small Siberian crab, *Pyrus cerasifera Spach, Pyrus elaeagnifolia, Pyrus salicifolia,* the mountain ash, hawthorn and the like—do not have an undesirable influence on new varieties grafted onto them. Very good for stock are seedlings of all Skrizhapel strains. In fact, this is the most ideal type of stock in

[1] In general, the influence of quince varieties as stock increases the fruit size and considerably improves the flavour not only of young, new pear varieties, but of old ones too. Thus, the well-known Curé pear grafted onto a wild pear produces indifferent, tart fruits, while on quince the taste improves wonderfully and acquires a dessert flavour. (Catalogue of the Bykovetsky nursery for 1914-15.)

every respect, it is undoubtedly thoroughly hardy for our parts, gives excellent nourishment to all varieties grafted onto it, noticeably improves the qualities of their fruit, increases the yield, and its root system can tolerate soils in which all other stocks perish—for example, it can quite well be planted on the sites of old dwellings, with a thick layer of manure, etc., accumulated over a period of many years.

Nearly as good are seedlings of Anis. Seedlings of Antonovka, Bel, Babushkino, Borovinka, Korichnoye and Borsdorf, by contrast, fall a long way short of these valuable properties.

The only thing suitable for pears is seedlings of local Bergamotte varieties; for cherries, seedlings of Vladimirskaya and of the wild sweet cherry; for plums, all varieties of damson.

3. The fine and very valuable American variety known as Yellow Bellefleur or Krasotsvet proved totally unsuitable for culture in our Tambov Province because its fruit buds lack frost resistance. If some of them do occasionally survive, fruits seldom set, and never attain the large size normal for this variety. In order to increase the hardiness of this type for our climatic conditions, I in 1907 fertilized several flowers of Bellefleur with pollen from Kitaika. One of the resultant hybrid seedlings was of particularly luxuriant growth, and as early as its seventh year bore large fruits of excellent flavour; but, contrary to expectation, they ripened very early—in the middle of August—and could only keep a few days, after which they spoiled rapidly. The following spring, several cuttings from true Bellefleur were grafted onto the lower branches, close to the trunk, to serve as mentor; and as a result, this new hybrid variety, which I called Bellefleur-Kitaika, suffered considerable change both as regards the appearance of the fruits and as to time of ripening. The fruits matured considerably later, and the length of time they could keep was increased by more than a month and a half in the very first year. Many of the fruits had an altered appearance: as against the smooth round shape of the first fruits, they took on a more oval, ribbed, Calville-like shape. Their weight reached forty-seven zolotniks—an increase of more than ten zolotniks. This change only began recently, and in succeeding years of the hybrid's fruiting, it should, of course, gradually develop and become more pronounced.

I shall accordingly continue to observe this highly interesting process carefully, and shall endeavour to give early information of it to anyone who evinces an interest in this splendid new type, which undoubtedly deserves, in view of its complete hardiness, abundant crops, and large size and dessert flavour of the fruits, to be classed among the first-rate varieties of Central Russia, both commercial and otherwise.

4. In the spring two years ago, I had to transplant a ten-year-old Bergamotte hybrid seedling in order to stop perpetual pilfering of its fruits. By an accident during the transplanting, the roots were so badly amputated that the tree was almost certain to perish. And so, to preserve a new variety which was an extraordinarily abundant fruiter, I had to graft cuttings from this tree onto the crown of another hybrid pear seedling—a

three-year-old which had not yet become completely rooted after being transplanted to a new location a year before. This being the case, all the grafts, while they did take, developed practically no new wood in the course of the summer, and all their growth buds changed to fruit buds; at the same time, the ungrafted branches of the three-year-old stock also put forth large numbers of fruit buds, which produced the first fruits the next year. Here we undoubtedly see an extraordinarily strong mentor influence exercised by the grafted cuttings of this very abundantly yielding variety, which induced the three-year-old pear seedling to start fruiting at such an unprecedentedly early age. Of course, one has to remember that in this particular case the influence of the mentor was further increased because the stock had been weakened by its recent transplanting. Possibly, if it had not been for this last circumstance, that influence would not have made itself felt so soon, or so strongly; its operation might have been delayed or lessened by the opposite influence of the individual power of the stock; but manifest itself it was bound to.

5. Besides the above-described method of grafting cuttings, other artificial factors can also be made to serve as mentors in training young hybrid seedlings. For example, artificial fertilization of flowers of a young variety with pollen of some other, old variety, chosen at will. The change thus induced in the properties of the new variety's fruits during several successive early years of fruiting becomes something like a habit with that variety, so to speak, and afterwards acquires permanence. It is the generally prevailing view among horticulturists that fruits resulting from fertilization with alien pollen show no change in their outward appearance. Actually, this is totally untrue, it is based on a too-superficial observation of hybridization and on the incorrect but generally accepted practice of referring to the pericarp as the fruit.

In reality, the true fruit, that is, the seed forming on the maternal plant, cannot possibly be of the same kind when produced by successful fertilization with alien pollen as when it results from fertilization with pollen of the same variety. For that matter, the pericarp, i.e., the edible flesh of apples, pears and small fruits, always changes too, whether in greater or lesser degree, in its outward form and internal structure. And while in old varieties this change is indeed little perceptible, in the fruits of young hybrid varieties, particularly in their first years of fruiting, it appears in very pronounced form. Apples and pears in such cases become much larger or, on the contrary, considerably smaller, their colouring grows more vivid or less, the flesh sweeter or sourer, and, lastly, the period of their ripening is advanced or retarded. And these changes are not always due solely to the hereditarily transmitted properties of the male parent; sometimes they are jointly induced by both parents or by their immediate ancestors, and often they assume totally unexpected forms. For example, a variety with brightly coloured apples, when crossed with another, which produces dark-red fruits with flesh red all through, yielded a fruit pure white in colour. This happened when flowers of the first fruiting of the new Bellefleur-Kitaika hybrid were fertilized with

pollen from a hybrid of the Niedzwetzkyana apple. The rest of the changes in the hybrid fruit, on the other hand, were altogether in keeping with the properties of the male parent. Thus, the fruits were considerably smaller than those resulting from self-pollination, their flesh was less juicy and more sour, the seeds also diminished in size and lost the diagonal protuberance on each seed which is characteristic of Bellefleur. Ripening time was two whole months later than usual. This experiment was repeated in 1915. The results were the same.

Let me quote another example. In 1914, the first flowers were put forth by a red-leafed seedling of an Antonovka-Niedzwetzkyana hybrid. Two of its dark-red flowers were fertilized with pollen from Bellefleur-Kitaika, and the rest of the flowers with pollen of its own variety. The difference between the two resultant kinds of fruit was as follows. The fruits from selfing were rather smaller, their rind, flesh, core and seeds were red all through; while the fruit which set from fertilization with Bellefleur-Kitaika pollen was somewhat larger and the red colouring of the flesh reached only as far as the core, while the core itself with its carpels and seeds remained entirely white, and seedlings reared from these seeds showed no signs of red pigmentation.

This experiment too was repeated last year—1915—and the same results were obtained. Of course, when working on hybridization, one observes such facts in large numbers, but to describe many of them would contribute nothing new and would merely be a needless repetition of what had already been said. I think these two examples, with the textual description and the drawings (done accurately from nature), are quite enough to illustrate the changes in hybrid fruits. They also indicate the often quite undesirable changes produced in the qualities of a new variety by annual fertilization of its flowers with insect-borne pollen from other varieties close by. Let us suppose that we have a young hybrid seedling which has begun to fruit: and next to it, or at no very great distance, is a tree of some variety with inferior fruit qualities, or, worse still, a wild species like the small Siberian crab. The influence of pollen from such a neighbour year by year will obviously cause deterioration in the properties of the young variety that has just started to bear; and it will be quite natural if, by the time the new variety reaches maturity and develops complete stability, this deterioration becomes permanently fixed in it. That is why all hybrid fruit seedlings must in their first five fruiting years be protected against such influences, why one must try to isolate them in one way or another from the harmful effects of having trees of the same species nearby. As a last resort, one must cut the flowers on the hybrid except for those that can conveniently be protected by bags of white cheesecloth or very fine gauze.

For the same reason, the breeding of constant fruit-tree varieties, which calls for the rearing of choice seedlings through several generations, is practically unattainable in orchard nurseries, though Max Löbner speaks so naively of its possibility. Good results in that can be secured only where young fruit seedlings can be completely isolated when they begin to bear, with a big

distance separating them from other plants of the same species. This could most easily be done on, for example, the government forestry reserves.

6. Besides the methods described in the preceding examples for encouraging the development of desirable qualities in young hybrids and keeping harmful external influences away from them, every horticultural originator must carefully watch all changes appearing in any part of a young tree's branches.

Dependent on whether a particular variation is useful or harmful, one must fix it by grafting the deviating branch-portion onto a suitable young one-year-old stock, or, on the contrary, eliminate it by pruning that portion. Here is an example: in 1914, the first fruits were borne in my nursery by a hybrid of White Winter Calville with Kitaika, and on one branch all the fruit was of a particularly attractive starry shape, while on the rest of the crown it was of just the ordinary round kind. A trait like this must be fixed by making a graft onto a young one-year-old stock with suitable qualities. Otherwise the deviating part, being of small size compared with the rest of the crown, may rapidly, often enough in a single year, lose its outstanding good qualities under the influence of the general constitution of all the other branches. Of course, the opposite may happen too, particularly if the new hybrid variety had a latent tendency towards such changes. But that cannot be depended on, it is better and safer to fix the sport variation the same year, particularly as removing a single cutting for grafting purposes cannot damage the rest of the branch.

As to branches with undesirable variations, they must be pruned immediately.

Speaking generally about fixing such chance and partial vegetative variations, it has to be noted that they are pretty unstable. As suddenly as they appear, so they may disappear without a trace the following year unless steps are taken to perpetuate them by artificial means. On the very first tree grown from the graft, we shall see that only some branches have the properties that interest us, while the rest are completely devoid of them. As soon as such a defect is discovered, the non-sport branches or portions of branches should be pruned at once, no matter how large they may be, and the crown built up only out of the best shoots and branches, with the sport characters most clearly marked. Then, after the tree grown in this way has been through at least five years of fruiting, one may feel confident that the sport variation is sufficiently fixed and may start propagating the new variety by grafting it onto young stocks.

7. It will also be expedient to fix in the same way all useful traits discovered on hybrid trees, even though they may not constitute real sport variations. Here is an example: in my nursery in 1915, an eight-year-old hybrid seedling—a cross between Reinette d'Orléans and a hybrid of Kitaika and Glogerovka—produced its first fruits, and they were of excellent flavour. Outwardly these fruits are like the brightly-coloured Glogerovka, while in texture and flavour of the yellow flesh they actually surpass the celebrated southern commercial variety known as Shafran, for which rea-

son I named this new type Michurin Pippin Shafranny. The fruits keep splendidly, without spoiling, throughout the winter. The tree is perfectly hardy for our parts. In general habit and in the structure of its flat crown, with drooping horizontal branches, it is exactly the same as Glogerovka. The traits and properties of this first-rate dessert variety reveal that the characters of all three types which contributed to its origination have been transmitted to various parts of its organism not evenly blended, but very nearly distinct. Thus, fruit shape and habit of growth have been inherited entirely from Glogerovka, and the texture and flavour of the flesh from Reinette d'Orléans or Shafran, while the tree's hardiness, the location and structure of the fruit buds, and also the slightly reduced size of the first fruits are evidently due to the influence of Kitaika. Then, quite unexpectedly, this new type exhibited the property of flowering very late, more than half a month after our local apple varieties; and this will, of course, be a very valuable asset if it is not lost. I should point out that, by itself, not one of the three progenitor types possessed this property at all; consequently, it could have appeared either as the result of the joint action of all three, or under the influence of latent extraneous factors. But in the latter event, this valuable property may quickly be lost if these extraneous factors should cease to operate. Accordingly, we must try to fix it; and while it is more than doubtful whether this can be done by the usual grafting method of perpetuating sport variations, yet I have on occasion been able to achieve good results.

Fig. 28. Garnich-Garnitsky Beurré (photo from I. V. Michurin's archives)

8. In conclusion, let me describe an interesting change that took place in my nursery in the Garnich-Garnitsky Beurré pear. Soon after this new variety appeared, I sent for cuttings of it and grafted them onto the crown of

an adult wild stock, which, I should remark, had not yet borne fruit. The first two years, these scions developed the normal amount of new growth, the third and fourth they bore large fruits of fine flavour. But the fifth year, the new growth of the shoots was no more than half a vershok; and when examined in the spring, all of the wood and bark was found to have suffered badly from the frost, and the wood denuded of bark was blackish in colour, the cambium layer retaining its normal colour only under the buds. In spite of this severe damage, both leaves and flowers developed normally, and fruits set, but their size and shape were altered beyond recognition; they were only a quarter as large as before, and of the ordinary shape of the fruits of semicultivated seedlings. The taste of the flesh and the keeping qualities of the fruits, on the other hand, hardly changed at all. In this condition the tree lived for another four years. After each winter, the shoots gradually turned black and withered away, but the fruit buds on the spurs remained, flowering and fruit-setting continued normally, and only the size of the fruits was very small. Finally, the grafted portions perished completely in the course of one winter. From this example we see, as I said at the beginning of the present article, the extent to which a young variety can change under the influence of an adult wild stock and a climate too cold for it to bear. We also find an indication here that the fruit buds are not always less frost-resistant than the other parts of the tree, etc.; exceptions also occur. One comes across varieties whose fruit buds are much hardier than the rest of the tree, but of course that already is an exception.

1916

HOW TO RECOGNIZE CULTURE CHARACTERS IN CHOOSING HYBRID SEEDLINGS[1]

The following may serve as such characters:

1) Relatively greater thickness of the main shoot, as compared with the main shoot in the other hybrids of the same cross and age. It is best to make the choice not before they are two or three years old. But to the discerning observer this character becomes recognizable already at the earliest age of the seedling, when it develops the third leaf after the cotyledons. If necessary, therefore, the choice can be made also at this early period of the seedling's growth.

2) Relatively larger size of the leaf blade and more wrinkly appearance, i.e., a shagreenlike appearance of the upper face, fuller pubescence on the underside, the serrature of the margins not so rough and deep, thicker and shorter leaf stalk (petiole) with rounder shape of the leaf and denser foliage serve as the best indications of culture. But all this, I repeat, is of significance only by comparison with seedlings of the same family and of the same age, otherwise it is easy to make a mistake.

[1] Notes from I. V. Michurin's diary.—*Ed.*

3) Greater pubescence of the end of the main shoot, its thickness, facetedness, and tendency to lesser branching should be regarded as the best sign of culture.

4) A good indication in apple hybrids which had cultivated American varieties among their parents is the tendency of the leaf blade towards a trilobed shape, even if in the slightest degree.

5) When a seedling out of a group is singled out for attack by insect parasites, such as aphids, for example, this may serve as an indication of the superior flavour of its future fruit.

6) A fully reliable sign of culture in pear seedlings is the frequency of leaf nodes along the stem, without development of side shoots or twigs, and also strongly projecting pulvini.

7) Sprouts with three or four cotyledons, and also with particularly large cotyledons, are a good sign of culture.

8) The colouring of the lower and, particularly, the upper face of the cotyledons is reflected in the subsequent colouring of the fruits. The same applies to the young shoot—if it is of a dark colour, the fruits too will have a deep colouring.

9) Premature loss of, or partial injury to, cotyledons has a very harmful effect upon the development of seedlings: the growth is retarded, the shape of all parts of the plant deviates towards wild forms; it is therefore essential to take good care to safeguard the cotyledons from injury until they have completed the process of nourishing the young sprout, when they drop away by themselves.

10) If a seedling completes its growth relatively much earlier than other seedlings of the same family and the same age, it is an unquestionable sign that this variety will produce summer-ripening fruit unsuitable for storage, although subsequently the time of maturation may be somewhat retarded, i.e., it may become an autumn and, as a rare exception, even a winter, variety. (Example: Bellefleur-Kitaika.)

11) Dense and large foliage is a good reason for assuming that the seedling is of good quality.

12) The best seedlings grown from round-shaped seeds and distinguished by thick leaves with a crenate margin represent in the majority of cases superior cultivated varieties.

13) Pubescence of the ends of the shoot and of the underside of the leaf in seedlings of good quality always develops only gradually, in the course of years; whereas in the first year of the seedling's growth it is manifested only in a slight degree. Consequently, in judging on the basis of this character, the comparison should be made only with seedlings that are also one year old, and not with apples of cultivated varieties of an older age. In the case of pear seedlings, pubescence of the shoot and the young leaves is, on the contrary, a sign of inferiority. What should be regarded as an indication of superiority in them is a possibly smaller serrature of leaves and a denser network of veins on the underside of the leaf, a finer and more graceful appearance of this venation. Only under the influence of complete mental

shortsightedness and utter cretinism can one make the absurd assertion that, in order to breed new cultivated varieties of fruit trees, the seedlings should be reared the same way as wildings for stock. . . .

1916 (?)

INFLUENCE OF THE SCION ON THE STRUCTURE OF THE ROOT SYSTEM OF THE STOCK[1]

The following fact which I have observed may serve as a particularly patent proof that a grafted strain exercises a strong influence upon its stock. Several strains of roses were grafted on a bed with wildings of the *Rosa canina*. Among them was a new *Rosa lutea* hybrid which I bred. Three years after the grafting all the roses from this bed were dug up for transplantation, and it turned out that, with few exceptions, all the specimens of the grafted *Rosa lutea* had absolutely smooth roots, without any branchings and fibrils as is usually the case with the *Rosa lutea* on its own roots. At the same time all the grafts of the other strains had a well-branched and fibrillous root system. Of course, such an example of particularly strong influence of a scion on a stock is an exception. Nevertheless, it is a fact, and horticulturists must bear this phenomenon in mind. Even though it may manifest itself in other plants in a lesser degree, but manifest itself it will all the same.

There is now perfect clarity concerning the influence of the scion on the stock and, vice versa, of the stock on the scion, and only an utter ignoramus will doubt that such influences exist. The difference between the one and the reverse influence depends only on the chance combination of stock and scion, on whether the stock or the strain grafted on it possesses a greater power of influence. Consequently, all the Western producers of new varieties, among them the American celebrity, Burbank, who advise that new varieties should be grafted before they have borne fruit, and on wildings or on branches of adult trees, make a gross error. For what they obtain by such means is not pure hybrids resulting from a cross, but vegetative hybrids between the scion and the stock. It is very much to be regretted that, in their articles, our learned horticulturists are wont on each and every occasion to cite these persons as their authorities, although they are in fact quite ignorant when it comes to the breeding of new varieties.

It is, in general, high time our learned horticulturists realized that they ought to refrain from making inappropriate statements in their articles to the effect that Russian horticulturists are wrong in doing this or that—statements they make in order to underscore their learnedness. You must admit that, in order to have the right to make such reproaches, one must oneself know enough about the matter and have personally accomplished something. Yet we see individuals who have not produced a single new kind of plant (and, even if they did produce one, it was by sheer accident), undertaking to

[1] Notes from I. V. Michurin's diary.—*Ed.*

pass judgment on those who have produced several hundred new varieties. They even make bold to argue about what they imagine is the wrong way of doing the job, always in such cases holding up as an example various famous Western botanists who are, in fact, as ignorant as they themselves in the matter of breeding new kinds of plants. The fact that these persons were outstanding classifiers in botany is no reason to think that they are just as outstanding in all branches of horticulture.

Such a famous botanist may, for example, turn out to be a very poor hand at grafting, in spite of the fact that there is nothing difficult about it and any charwoman can be taught to perform it to perfection. After all, no one will regard every physician as a good surgeon, nor will an oculist or gynecologist be regarded as an authority on the treatment of diseases outside his speciality.

Similarly, all those Tourasses, Van Monses, Knights and others, judging by their works, did not know enough about the breeding of new varieties of plants, and it is extremely out of place, to say the least, to cite these botanists as authorities on questions of breeding new plant varieties, or to use their absolutely erroneous writings as a basis for judging contemporary workers in this field. All the more so since in the writings they have left behind there is not a single consistent and complete description of the production of any variety, and even if you do find there some fragmentary remarks on the subject, you may be sure that their authors, were they alive today, would feel ashamed of the mistakes contained in those remarks.

1916

MATERIAL FOR THE FORMULATION OF RULES FOR TRAINING HYBRID SEEDLINGS IN PRODUCING NEW VARIETIES OF FRUIT PLANTS

Through the kind offices of the most esteemed Grigori Khristoforovich Bakhchisaraitsev, and thanks to his correct and just appreciation of the cardinal importance of improving our assortment of fruit plants by producing new varieties, I have been afforded the opportunity of publishing a number of articles on this subject in the magazine *Sadovod* in the course of 1917. In them I shall endeavour to impress upon Russian horticulturists the absolute necessity of devoting prime attention to the work of improving agricultural crops generally and cultivated fruit plants in particular as a means of raising the standard of our agriculture. I shall at the same time describe several of the more reliable methods of attaining this—methods which I have evolved and tested personally, in forty long years of practical work in this field. Considering that articles offering guidance on so extremely an important branch of horticulture are to appear in print for the first time, and that, moreover, they are based exclusively on the findings of many years of research by the author, I make bold to hope that the reader will give them due attention, for I have written them with the sole purpose of contributing my

share to the development of Russian horticulture. My purpose is to discuss and help find a solution for some of the problems of horticulture pertaining to the possibility of cultivating high-quality varieties of fruit plants in the central and northern parts of Russia despite the severe climate there. To substantiate my arguments, I shall describe a number of practical experiments, by repeating which any horticulturist can himself verify the unquestionable truth of my statements. In conclusion, I shall describe some splendid new varieties of valuable, highly profitable fruit plants, which I produced by crossing the best foreign varieties with our own hardy cultivated and wild varieties.

I deem it necessary to begin with a brief survey of the state of horticulture in our country, particularly of commercial horticulture in Central and Northern Russia. Turn your attention, gentlemen, to the present sorry plight of our horticulture: all commercial orchards of any appreciable size are made up exclusively of old, low-yielding varieties which produce one harvest in two, three and sometimes five years, and, what is more, the best of these varieties seldom fetch as much as three rubles per pood on our markets. At the same time we import millions of poods of fruit annually from the South and from abroad, paying six, ten and fifteen rubles per pood. What a fortune this is costing us, and for the only reason that the imported fruits are greatly superior in flavour to our own cheap, home-grown product. Besides, the low price of our local produce, coupled with the present high cost of labour, and the ever-increasing competition of imported fruits, is all but undermining native commercial horticulture. Many orchards have fallen into a state of decay, while others are being chopped out by their owners because under present conditions they cannot be run on a paying basis.

The situation would be quite different indeed were we to improve, by one method or another, our assortment of fruit plants by introducing new, more productive varieties. This would multiply profit yields several times over and would more than compensate for the most painstaking care of the orchards. It would also considerably reduce the harmful effect of foreign competition. It is high time our individual horticulturists, and all horticultural societies, gave their undivided attention to improving the assortment of native fruit plants. We must realize, at long last, that for centuries we have been simply marking time in this respect.... Tell me, if you can, what new high-quality varieties have we acquired? What have we added to our orchard assortments? Certainly, our traditional Antonovka, Borovinka, Babushkino, Bessemyanka and Tonkovetka existed in our great-grandmothers' time. Are we to believe that these varieties are so good that there is no room for improvement? Of course not. I am sure no sensible orchardman will dispute this. Indeed, if our orchards produced fruit that was really up to present-day market requirements, there would be no demand for the imported product.

The profits our orchards yielded in the past, from old varieties, were fully in keeping with the conditions of the time; but that is a thing of the remote past. Conditions today are altogether different, and in all fields of

endeavour we must adapt ourselves to them. Failing that, not only our horticulture, but every other branch that does not keep up with the requirements of present-day life is doomed to perish.... Yet, it appears that our Russian horticulturists, and the various horticultural societies, are determined not to heed this. These societies, presumably, were founded for purposes that have very little in common with horticulture, otherwise one is at a loss to explain the utter futility of their activities. Very likely I will be told that I am wrong, that practically all our horticultural societies and a great number of agronomists make it their prime duty to improve fruit-plant assortments. But if that is the case, gentlemen, where are the results of their work? Where are the new varieties they introduced into our orchards? There are none, nor could there be, for talk and good wishes alone will not produce them. As for attempts at practical work in this field, we know only of negative results. And I should add that these attempts failed solely because incorrect methods were employed in acquiring new improved varieties. Plants were always chosen ready-grown, bred in warm countries where their properties developed under the influence of favourable climatic conditions. Naturally, such alien settlers were not suitable for our localities with their harsher climate. The vaunted acclimatization methods, for all their subtleties, are of no avail here. All such imported delicate varieties inevitably perished, sooner or later, or proved entirely unprofitable because of low yields and deteriorating flavour.

I shall not enlarge upon this by enumerating the many adverse results that were the outcome of using this method for acquiring better varieties of fruit plants. My long years of work have fully convinced me of the uselessness of this sort of acclimatization. Instead, I shall discuss the only unquestionably correct method of improving the quality of our fruit plants. That method is to add to existing assortments our own new and better varieties, bred in our parts from seeds derived from crossing the best foreign varieties with our hardy cultivated local strains and their native wild relatives.

This method is certain to bring success. I make this assertion on the basis of my work on hybridization, which has enabled me to obtain a substantial number of new varieties of fruit plants hardy enough for our localities and bearing fruit of a greatly superior quality than that grown from old varieties. Many of the new varieties can successfully compete with imported plants. The reader may have seen a description of one such valuable new sort in my reply to the Student Circle of Amateur Horticulturists at the Moscow Agricultural Institute, published in the *Sadovod,* No. 1, for 1917. The description I refer to makes it quite clear that when hybridization is employed, severe climatic conditions are not an insurmountable obstacle to the cultivation of high-quality varieties in our orchards, as many mistakenly believe. Everything depends upon making a well-judged selection of the pairs of plants to be crossed and, chiefly, on judiciously training the young hybrid seedlings. Denied proper training, not only a plant, but even a human being—a more highly-developed organism—will easily lose the rudiments of cultural characters inherited at birth and go wild. Besides, it should be borne in mind

that the training regimen for a young hybrid seedling of a future new variety of fruit plant differs greatly from the ordinary care required by young grafts of established varieties that have existed for scores of years. The characters and qualities of the young hybrid seedling are only just being evolved and their development can easily be made to deviate in one or another direction. The development of a certain quality may be weakened, while that of another augmented, as desired. When, however, training a young graft of an old variety whose characters and qualities have long been developed and are fixed, we are dealing with a very stable form which will submit to change only with the greatest reluctance, despite the most radical alterations in training conditions, and then only to a very slight degree, and, in some cases, only for a brief period. If, for example, an Antonovka is grafted, the young graft will grow into an Antonovka tree possessing all the specific characteristics of Antonovka, no matter what the conditions of cultivation are. The only difference is that one tree may bear larger fruit, another smaller fruit, or on one tree the fruit may be slightly tinged with red while on another they may not be, etc. It is an altogether different matter with the training of hybrid seedlings. Here the qualities of the future new variety depend almost entirely on the training regimen. Subjected to an incorrect training regimen the very best hybrid of cultivated varieties is liable to degenerate into a complete wilding, and, conversely, by employing proper training methods on a cultivated hybrid seedling with rudiments of undesirable characteristics, we may retard the development of these bad qualities and, in some cases, even eliminate them altogether and thus obtain a good new variety.

Unfortunately, no useful guidance on the subject is to be found in print, not even the briefest, either in Russia or abroad. Opinions expressed on this subject are everywhere based on false, entirely erroneous conceptions, most of them the result of a too superficial knowledge of the work and mistaken theoretical conclusions that have not been subjected to the test of practical experimentation. Many such incorrect views are to be found in all our reference books on horticulture, even the very best, and they are even more widespread in gardening journals and various pamphlets. They come from the pens of men with little or no experience in breeding new varieties of fruit plants. Some of the authors are outright ignoramuses who take it upon themselves to affirm that breeding new varieties of fruit plants is just a waste of time, or, at any rate, it is not difficult work and does not require much knowledge, experience, labour or expense. I leave it to the reader to judge how false is this preposterous view. Of course, it all depends upon what these gentry actually mean by breeding new improved varieties of fruit plants. If they have had occasion to plant a dozen or two seeds of some fruit they happened to come across, nurse the seedlings to fruit-bearing maturity, and then select from among them some single specimen which fortuitously produced fruit of tolerable flavour, then this, certainly, does not require much work. It can be accomplished by any ordinary gardener; it requires neither extensive experience nor special knowledge and, indeed, a very small amount of actual labour effort and expense. You will find through-

out Russia hundreds of such sorry orchardmen, not just three or four as the esteemed M. V. Rytov writes. But all they have to show for their efforts over a course of several score years is a paltry collection of two or three varieties, which have by sheer accident borne good fruit and are worth cultivating. But the vast majority of varieties obtained by this primitive method usually turn out to be of no use whatsoever and only serve to corrupt garden assortments. Naturally, growers of this type, far from making any useful contribution to the development of scientific horticulture, in most cases cause a good deal of harm by their erroneous views and conclusions.

In addition to magazine articles dealing with the breeding of new fruit-plant varieties, one encounters every now and again pamphlets on the subject written by persons who have not only never produced a single new variety, but who hardly know how to go about this work, as one readily learns upon reading the pamphlets. Yet they have the audacity to address various gatherings and conferences of horticulturists, and take advantage of the ignorance of their audiences to pass judgment—with an air of brazen defiance—on the work of men immeasurably more experienced in this field. The amazing thing is that no one ever gets up and asks the speaker what he himself has done in this particular branch of horticulture. Has he produced a single new variety of fruit plant, even of the most mediocre quality? After all, gentlemen, one cannot undertake to discuss such a serious and extremely complicated subject without long years of personal practical experience, merely on the basis of haphazard information about the work of others. As often as not, such information is wrong, communicated in a garbled form or misinterpreted. Again, the information may prove to be of no practical use at all if, for instance, the experiments were made on plants of distant genera. Thus, to cite one example, Mendel's detailed observations of the crossing of different varieties of peas are under no circumstances applicable to the crossing of fruit trees, if for the only reason that the development of seedlings of annual herbaceous plants cannot be subjected to the influence of the numerous factors to which the seedlings of perennial fruit trees are inevitably subjected for a period of many years until they are fully developed (and matured).

Yet, some of these influences frequently completely alter the properties of the seedling, causing it to deviate in the direction of one of its nearest ancestors. Besides, I have discovered from my many years of observation that in most cases the characteristics inherited by fruit-tree seedlings from their nearest ancestors through their parents are those which predominated in the latter in the year of crossing, and to a great extent they depend on the climatic conditions of each given year, on the age of the crossed plants, the state of their health and many other factors. Judge for yourself, what room can there be here for the application of pre-calculated percentages of the characteristics which the seedling must inherit from one or another of the crossed parent plants in accordance with Mendel's pea laws, or in keeping with the observations made by others on nettles, corn and flowers? So far very scanty data on observations of fruit trees made from this angle

ties at the very beginning as a result of the fertilization of the flowers of the maternal plant by male specimens of other races (varieties) or even of other species are particularly susceptible to substantial changes of characters and qualities, and the less kinship there is between the pairs of plants crossed in this way,[1] the greater will the tendency towards alteration be in the young seedlings. Considerable effect in hybridization is also obtained by placing the maternal plant, during fruiting, in climatic and soil conditions that are different from those it was accustomed to.[2] In all such cases the organism of the young seedling plant is ousted, so to speak, from the track of natural functions customary to the species or variety of its maternal plant. The result is that its properties lose their stability; and, subjected to the influence of a new environment, the plant gradually adapts itself to it, develops new characters of its own and thus becomes a new variety of fruit plant. The development of any given quality in such a new variety depends largely on man's ability to devise a suitable training regimen for the young plant, starting with the earliest stage of its conception and up to the first few years of fruiting when its properties are definitely evolved and complete stability and invariability of all the characters is secured.

That is why, gentlemen, the simple training regimen for seedlings, ordinarily applied to plants, including seedlings of wild fruit trees grown for stock, is under no circumstances applicable to the breeding of improved new varieties of fruit plants. Otherwise we will never achieve our purpose: we will not obtain the desired cultivated variety, practically all our seedlings will turn out wildings, with only a tiny percentage of semicultivated mongrels. I believe that every fruit grower has repeatedly observed this in practice, and this is the only explanation for the absurd conviction of all growers that only wildings can be obtained from planting the seeds of cultivated varieties of fruit plants. This, they allege, is the result of atavism, that is, the generic tendency of all plants to revert to the constitution of the primitive forms of the wild species. But that explanation of our learned horticulturists will not stand up to serious criticism. Indeed, can all this be attributed to atavism? True, if every seedling we grew from seeds of a cultivated variety were trained in an identical environment, with the identical influences of diverse accidental factors operating which affected the development of the maternal variety, and if the seedling nevertheless tended to revert to its wild ancestor, that would be another matter and one might agree with the explanation that ascribes the causes to atavism. But the creation of such a set of conditions artificially, in its entirety and diversity, is out of the question, since many of the conditions are totally unknown to man. Consequently, in our part of the country the seedlings grow up under totally different conditions, their forms are evolved under the influence of a different combination of diverse factors, with the result that they must inevitably deviate from the form of the maternal plant. But the cause of such deviation, according to

[1] Of course, within one genus.

[2] For example, the cultivation of imported delicate varieties in pots, as dwarf specimens.

my numerous observations, has very little to do with atavism inasmuch as hardly any seedlings of cultivated fruit-plant varieties really tend to deviate structurally in the direction of their distant wild ancestors. On the contrary, a certain percentage of the total are merely different variations of the offspring of cultivated varieties wasted away due to improper care. As for the rest of the seedlings, which really possess traits of wildness, in a large number of cases this is due not to the influence of atavism but, firstly, to the direct effect of fertilization of the maternal flowers by wind or by insects carrying the pollen from nearby wild plants,[1] and, secondly, to fertilization by pollen from grafted trees of certain cultivated varieties[2] which, under the influence of the wild root system of the stock, form pollen which has all the properties of wild species. Both these statements are fully confirmed by the fact that seedlings with wild properties are never derived from the seeds of ungrafted trees of cultivated varieties if their blossoms are completely isolated from pollination by outside varieties. The same is true when such trees are used as the male parent.

As for the very frequently observed appearance of good or bad qualities in seedlings, which they inherit not from their parents, but through them from their grandparents, both in the male and female line, this phenomenon cannot be regarded as a reversion to distant wild ancestors. This is not so, because, firstly, the qualities do not go back further than the second generation and, secondly, because deviation is not confined exclusively to reversion to the wild primary species.

Again, we must bear in mind that all the so-called culture qualities of fruit plants—large-sized fruit, savoury pulp, etc.—have been obtained by man only by gradual selection, over a period of many years, of individual specimens cultivated under conditions of extra nourishment as a result of which some parts of the plant, or the structure of the whole plant organism, have acquired greater succulence. And, of course, it is quite natural that lacking this extra nourishment the culture qualities of the plants may gradually disappear, their fruits may become smaller and the taste of the pulp coarser. The offspring of such plants will regress even more rapidly in this respect, but nonetheless this deviation will not be a manifestation of atavism because the structure of seedlings of such worn-out cultivated varieties will differ radically from that of related wild species, providing there has been no pollination of the maternal plant by the neighbouring wild plants, or by cultivated varieties in which the characters inherited from the parents are not evenly distributed through all parts of the organism. Frequently, in these varieties certain characters may remain latent in some parts of the plant, or disappear altogether, whereas in other parts the same characters may appear in full force. For example, despite the presence of numerous cultural qualities in

[1] In this case we might concede the influence of atavism, expressed in the preference of all cultivated varieties for wild-plant pollen during fertilization.

[2] For example, the pollen of the common Antonovka possesses the properties of the wild species.

varieties in the production of which wild species have taken part directly, or even one (but no more) generation ago, one may frequently observe that some parts of the plant fully retain the structure and properties of the wild species. Consequently, a large percentage of seedlings—sometimes all seedlings—of trees of such varieties used as parents are close to the wild species in structure. As I have pointed out before, a graphic example of this is our well-known common winter Antonovka; the pollen of its blossoms, its seeds and seedlings all bear the characters of the wild species, which evidently indicates that this very old Russian variety originated directly from some form of our forest crab apple. A phenomenon leading to analogous consequences takes place when one of the parent plants retains the characters of the wild species not in the sexual parts of the organism, but in other parts, for example, in the small size of the fruits, in the structure and shape of the leaves, shoots or, *finally*, in the structure of the root system. Not infrequently deviations of this kind are reflected in a single branch or in an offshoot of the root system, and are so minute as to escape the notice of the most experienced gardener. Nevertheless, this partial deviation may come out in the offspring, in the form of numerous seedlings with the structure of the wild species. Lastly, it should be remembered that a large part of our fruit trees are grown on the stock of wild species, and that the substituted root system has a strong influence, if not on all the grafted cultivated varieties, at least on some of them, as well as on the structure of the seeds and the seedlings obtained from them; this causes their structure to deviate in the direction of the wild species.

Another thing to be taken into account is that generally in many of the seedlings of the very best cultivated varieties of fruit plants the culture qualities are so indistinct in the structure of the plant during the first years of growth that the inexperienced observer can seldom distinguish them from ordinary wildings and, consequently, in most cases they are mistakenly classed as such. This mistaken conception springs from our reluctance to realize that both in outward appearance and in structure the parts of the young plant organism cannot acquire the forms which they ordinarily develop only gradually, over the definite period of time which every variety requires to reach maturity. Just as a young child cannot have the same appearance as its parents, but merely bears a faint resemblance to them, one cannot expect to find in a young seedling a strong resemblance to its parent plants. For instance, the leaves of a young seedling, in the first years of its growth, are always much smaller and thinner and the margins much more serrate, while the underside of the leaf blades is covered with hardly discernible down (in apple trees); the rare network of the veins is not so clearly outlined, the shoots are much thinner, seldom covered with a light down, and then only at the very ends; the lateral branches are short and often take the form of prickly thorns, etc. Given proper training by man, all these seeming external defects of young fruit seedlings disappear gradually as the years go by. Again, man can considerably reduce the length of time required for such improvement and greatly increase its degree. It should also be noted in this connection that in all fruit trees the seeming defects in structure men-

tioned above disappear gradually, only as the tree adds parts in the succeeding years, and are retained almost without change in the lower, previously formed, parts of the plant for a very long time, sometimes forever. This can easily be seen by examining the structure of offshoots from the root neck of an adult fruit tree grown on its own roots from seed. Offshoots from the root neck of an old ungrafted tree unfailingly undergo all the changes in appearance, from the time they are sprouted until complete maturity, in exactly the same manner as this now adult tree did in its youth. That is the reason why in the reproduction of a new variety of fruit tree by grafting or planting cuttings, I must warn against using cuttings taken from the lower branches, or, especially, from the offshoots of the root neck, except when this new variety has been grown from a shoot or from a rooted cutting taken from the upper part of another tree of the same variety, usually grown from seed. If these conditions are not observed, i.e., if cuttings or buddings are taken from the lower part of a seminal tree of the new variety, the result will be an entirely different variety of much lower quality than the one selected for propagation. The above is applicable to all pome trees—apples, pears, mountain ash, etc. There are rare exceptions among the stone-fruit trees, as, for instance, several kinds of Reine Claude, sour cherries, peaches and apricots, particularly among the seedlings of old varieties propagated exclusively by planting seed.

Similarly, the first fruit borne by trees of new seed-grown varieties must be regarded as a newly-developing part of the young plant organism; the fruit improves in appearance and taste only gradually. The first fruiting often yields very small, coarsely coloured and not infrequently poorly-flavoured pulp. Only with years of growth and a proper training regimen does the fruit develop to a size normal for cultivated varieties; its flavour and storage qualities improve with every passing year so that often an early summer variety develops into a winter variety whose fruit preserves its freshness throughout the whole of winter. But such progressive improvement can be attained only by a correct training regimen, otherwise most of the seedling's traits deteriorate under the influence of diverse harmful factors, mainly, insufficient nourishment.

Indeed, I believe that atavism has absolutely nothing to do with the cases I have cited of wild seedlings growing from seed of cultivated varieties. The explanation is quite different and simple. It stands to reason that in enumerating and describing the causes for the appearance of wild seedlings from seeds of cultivated varieties it is not my purpose to dispute the influence of atavism in general. That would be very improper on my part and would serve no useful purpose. The only purpose of my description is to help the reader understand the real causes of this phenomenon and teach beginners in hybridization how to avoid the numerous failures which nearly always accompany practical experimentation, and particularly the difficult work of propagating the young, new varieties of fruit plants they have created. I would therefore request the reader to regard my writings on the subject only in this light. Cognizance should be taken of the cases of possible failure

I have enumerated, and of its real causes. It is particularly important for every novice in hybridization and plant training to exercise the greatest care in the selection of parent plants for new varieties, as well as in the reproduction of existing new varieties. Unless this is done, the very best varieties, if bred and propagated by persons possessing insufficient experience, far from improving our assortments, can easily corrupt them.

Unfortunately, not only the amateur, but the trained professional orchardman too, both here in Russia and abroad, is utterly unaware of the harm that can result from the activities of persons lacking sufficient experience in breeding and propagating new varieties. I shall enlarge upon this aspect in subsequent accounts of my observations; at present I wish to draw a number of *conclusions* from the foregoing concerning more or less correct methods of breeding new varieties of fruit plants.

1. In selecting plants for the role of propagators one should as far as possible give preference to strains derived from manifestly good cultivated varieties, i.e., varieties which had no wild forms among their parents, for otherwise the influence of the wild forms may manifest itself in the transmission of poor qualities to the grandchildren.

2. My observations of numerous hybridization experiments reveal a tendency of hybrid fruit plants to inherit the properties and qualities not from the parent plants but, through them, from their grandparents. It is desirable, therefore, in selecting varieties of plants for crossing to know the properties and qualities of their parents, for this may prove of great value in planning, at least approximately, the qualities desired in the future new hybrid varieties.

3. In replenishing the assortments of fruit plants in our orchards we should introduce only varieties whose qualities, properties and productivity are greatly superior to those of the old local varieties. The new varieties should have as their chief merits a complete resistance to local climatic conditions; in particular, the aerial parts of the plant should be completely resistant to winter frosts, and the blossoms should be able to endure morning frosts in late spring; hence, preference should be given to late-blossoming new varieties. The bark on the trunk and branches should be able to withstand sun-scorching. It is not desirable that the new varieties make too great demands with respect to soil composition; also, preference should be given to varieties whose leaves and fruits are more resistant to rust, blemishes, rot caused by parasitic fungi, and to pests. The yield should be abundant and annual, and both in flavour and general appearance the fruit should be, I repeat, superior to that produced by old local varieties. Duplication of qualities is absolutely unnecessary here. Preference should be given to winter varieties with fruit that has good keeping qualities and can stand long-distance transportation; these varieties are more profitable commercially. From the time the fruit is set until it is picked it should cling firmly to the branches and be able to withstand strong winds. The need for cross-pollination by a definite neighbouring variety for the fruit to set should be regarded as a grave shortcoming.

4. And so, in order to produce new varieties possessing the above-mentioned qualities we resort to hybridization, i.e., to the artificial crossing of selected pairs of plants of different varieties. From the seeds derived from such crossing we grow a seedling of a new variety; to improve the taste and appearance of the fruit of the future new variety we select one plant of the pair to be crossed from the best foreign varieties, and to impart to our new variety maximum resistance to local climatic conditions we must choose the other plant of the pair from the hardiest local cultivated varieties. If no varieties suitable for the purpose are available, we should choose a plant of a local wild species, or, finally, as a last resort, we might use plants grown locally from seed received from colder areas. In selecting the variety of the second plant of the pair to be crossed, preference should be given to plants which, while possessing marked frost resistance, will exert the least influence on the desirable qualities of the hybrid, and will not alter them for the worse. The plants chosen should be generous bearers and should possess other useful qualities.

5. If plants of wild species must unavoidably be used for crossing, especially those from a colder habitat, they should be chosen at a young age, in their first year of blossoming, so as to diminish the tendency, so potent in wild species, to hereditarily transmit all their properties to the hybrid.

6. On the basis of repeated, and therefore thoroughly tested, experiments in selecting strains of fruit plants for crossing in our part of Central Russia, I recommend the following varieties:

I. *Apple trees*. In crossing with the best foreign varieties I have found our cultivated Kitaika most suitable in all respects for imparting to the future hybrids maximum resistance powers; it produces hybrids of high frost resistance, abundant yields and does not exert a negative influence on the flavour and size of the hybrid's fruit. By crossing the cultivated Kitaika with selected foreign varieties I have produced the following new winter varieties of high quality apples: Bellefleur-Kitaika, Borsdorf-Kitaika, Calville-Kitaika,[1] Kandil-Kitaika, Shafran-Kitaika, Pippin Shafranny, Michurin Pippin,[2] Pippin Record and several less important sorts. It should be noted, moreover, that all of these high-quality varieties are much superior to our established cultivated varieties of apple in resistance, size of fruit, flavour, general appearance and yields. I have also bred hybrids for cultivation in more northerly parts than ours by crossing the Kitaika with highly frost-resistant old varieties grown in the orchards of Central Russia. The resultant varieties are: Antonovskaya Kitaika, Arkad-Kitaika, Kitaika Anisovaya, Bel-Kitaika, Vorgul-Kitaika, Reinette-Kitaika, Yaĭchnaya Kitaika and others. The quality of the fruit of these varieties is as good as, or only slightly inferior to, our own old cultivated varieties, but the fruit is large and the plants are much more resistant to winter and spring frosts. In addition to the hybrid

[1] Later Michurin described this variety under the name Shampanren-Kitaika.—*Ed.*

[2] There is reason to believe that Michurin subsequently renamed this variety Pippin-Kitaika.—*Ed.*

varieties which bear large fruit, there are some quite good ones that bear small fruit, for instance, Kitaiskaya Dessertnaya, Aromatnaya Kitaika, Zimnaya Kitaika. They are of value only to the northernmost apple-growing areas.

Very interesting and in the highest degree useful from the scientific standpoint are the crossings I made of several cultivated varieties of apple with the long-known red-leafed Niedzwetzkyana apple. The seedlings obtained from

Fig. 29. Bellefleur-Kitaika (from I. V. Michurin's archives). Reduced

the hybrids, from the earliest moment of their development from the seeds, made it possible to see and observe the gradual development of the hereditarily transmitted characters of the parent plants to their offspring by the different degrees of red colouring of all the parts of the seedling, beginning with the cotyledons and ending with other parts when they are completely developed in the plant at a riper age. All this can easily be seen even by the most inexperienced observer, by a neophyte in hybridization, owing to the red colouring of the leaves, shoots, bark and wood, the similar colouring of the roots, blossoms, rind of the fruits and, lastly, by the colouring of the very flesh of the fruits and their seeds. In addition, by these observations one can most easily, quickly and, chief of all, surely demonstrate the utter unsoundness and inapplicability to the hybridization of fruit plants of

the celebrated Mendelian pea laws, which have been so insistently recommended to us by our horticultural scientists, who actually have proved to be utter ignoramuses in the matter of hybridization. Any amateur horticulturist may easily convince himself of the correctness of this conclusion of mine if he repeats my experiments in crossing the Niedzwetzkyana with any cultivated variety of apple in his own orchard.

By crossing the red-leafed Niedzwetzkyana apple, which, by the way, is not hardy in our parts of the country, with certain cultivated varieties, I have produced several very hardy varieties with large-sized fruit which keeps fresh all through the winter and spring. The colour of the rind is very dark red and if the plant is self-pollinated, the very flesh of the fruit is an extraordinary dark red all through; on the other hand, if the blossoms of Niedzwetzkyana hybrids have been pollinated by other cultivated varieties, the flesh of the fruit is either slightly tinged or remains pure white, depending upon the male parent's individual power of hereditarily transmitting its properties. In the spring, when all the trees of these hybrids are in bloom, they present a spectacular sight, with their big purple blossoms against the dark-red background of young foliage; they remind one of some tropical plant of rare beauty. At first glance, some visitors to my nursery took them for magnolia, others thought that they were an exceptionally tall arboreal variety of azalea. Fruit from the first Niedzwetzkyana hybrids is only of average flavour, and should be classed as cooking apples, and as such they will be found extremely useful. The first Niedzwetzkyana hybrids were obtained by crossing with our common Antonovka: two Niedzwetzkyana apples produced fourteen seeds; seven of the seedlings derived from them had red leaves, while the other seven had ordinary green leaves. Thus, from the former I got seven red-leafed varieties, which I named: Paskhalnoye,[1] Kagor, Rubinovoye,[2] Azalea, Visant, Detskoye. As for the green-leafed hybrids, I got only one variety, but an excellent dessert sort which kept from September to April. I named it Arkad Zimny because of the extremely sweet flavour of its fruit. I crossed these first hybrids again, this time with the best, choice cultivated new varieties of apple trees. They pollinated the blossoms of Bellefleur-Kitaika and Pippin Shafranny. A very interesting phenomenon was observed here—up to twenty per cent of the seedlings grown from the seeds derived from this cross were coloured a dark red all over, even darker than their grandmother, the true Niedzwetzkyana apple tree. Of these hybrids from the second crossing four varieties have been selected so far: Bellefleur Purpurovy, Pippin Bagrovy,[3] Trilobed Bellefleur and Bellefleur Rugosa.

Of late a Mongolian semicultivated variety, called Saioli in its native land, which produces long pear-shaped fruit said to have good flavour, has been

[1] Later I. V. Michurin renamed Pashkhalnoye Anti-Paskhalnoye.—*Ed.*

[2] In Michurin's later works the Rubinovoye variety is described under the name of Yakhontovoye.—*Ed.*

[3] Later Michurin renamed this variety Pippin Bagryany.—*Ed.*

introduced into cultivation and I have acquired samples from various places to make tests. The trees have proved fully resistant in our parts, and therefore crossing this rare variety with cultivated varieties of apple should prove highly interesting. Unfortunately, my type specimens of Saioli have not yet blossomed and I have so far only managed to obtain a vegetative hybrid between a Saioli and a new Bellefleur-Kitaika variety which bears large-sized fruit. We shall find out about the qualities of the new variety later.

As for the small Siberian crab apple, which the late Grell introduced into our orchards for cultivation, and its variations, I positively recommend that this species be expelled from the orchard of every plant breeder in our locality, for this Siberian native does much more damage than good whether used as propagator or as stock for reproducing new varieties by grafting. True, hybrids obtained by crossing cultivated garden varieties with the small Siberian crab begin to bear fruit very early, sometimes the fourth or fifth year after germination from the seed, and their yield is very large, but in the vast majority of cases their fruit is very small, rather like midget Kitaika apples, and the flavour of the pulp is almost always poor.

Young new varieties grafted onto the stock of Siberian crab usually deteriorate, for they are unable to withstand the extremely energetic influence of this wild species. The result is that the structure of the new, still young, varieties alters for the worse, their fruit becomes smaller, the taste of the flesh becomes much coarser, etc. I noticed the same phenomenon, although to a much slighter extent, when several of our old orchard varieties were grafted onto Siberian crab stock and, whatever partisans of this stock may say, I, for one, simply see no reason for preferring it to seedlings of our cultivated Kitaika apple tree, an excellent stock in all respects, particularly since the trees grafted onto Kitaika are not a bit less frost-resistant than trees grafted onto Siberian crab stock.

I recommend the following for hybridization purposes as the most resistant of local cultivated varieties: Bely Naliv, small-sized Grushovka Moskovskaya, Anis and all the variations of Skrizhapel. This latter variety, although not distinguished by the marked resistance powers of the former strains, produces the largest number of hybrid seedlings with the best culture properties when used as the maternal plant.

Besides, ordinary Skrizhapel seedlings are the very best stock, both for young varieties which are still pliable, as well as for all our old cultivated varieties of apple trees. Fruit of the trees grafted onto Skrizhapel seedlings never deteriorates in quality; on the contrary, in many cases it has been known to improve. Another consideration: trees grafted onto Skrizhapel seedlings are much less particular about the composition of the soil, so that, for example, they can very easily be transplanted to used orchard land having thick and not yet decomposed layers of manure, which apple trees grafted on other stocks simply cannot endure.

I have obtained several very good hybrids by crossing foreign varieties with our old local cultivated strains of apple trees. Thus, from the seeds

of our Antonovka whose blossoms were pollinated by Ananas-Reinette, I managed to obtain a new variety, true, only one, but excellent in all respects and very productive, which I have named Slavyanka. It bears beautiful fruit of fine flavour which keeps well all through the winter, and sometimes till the new harvest. The tree itself is very hardy and a generous bearer. Another new variety, Knyaz Truvor,[1] obtained from seeds of Skrizhapel and pollinated by Blenheim Reinette, possesses qualities almost as high. Still another hybrid is yellow-flesh Antonovka Shafrannaya.

Mention should also be made of the excellent new varieties, already known to many who buy from my nursery, which I produced by fixing the accidental qualities of sports and vegetative hybrids. Among the first is a sport of Antonovka Moghilyovskaya Belaya, which differs from Antonovka in bearing exceptionally large, pure white fruit weighing up to 600 grams; I have named it 600-gram Antonovka. Of the vegetative hybrids I have bred, a variety outstanding for the fine flavour and good winter keeping qualities of its fruit is Reinette Bergamotte.

A detailed description of these varieties, as well as of many others I have produced, mention of which the reader will find in subsequent articles, will be given, with pictures of the fruit, sometime this or next year (at the end of my series of articles if, of course, the editors of *Sadovod* think it desirable to print a description of this kind on the pages of their magazine, concerning which I request them to publish their reply in an early issue so that I may have time to prepare the descriptions).

II. *Pears*. I have not succeeded in discovering a single locally-cultivated variety, or local forest wild plant, possessing sufficient hardiness and other properties to make it fit for use as a propagator. All crossings gave very unsatisfactory results. One example is the Tonkovetka, comparatively the most resistant pear we have. Contrary to all expectations its hybrids, obtained by crossing with foreign varieties, with very few exceptions, proved non-resistant to the rigours of our winter. In most cases hybrids derived from different combinations of crossed pairs bore small fruits with insipid, almost tasteless flesh. Of the large number of such hybrids that I trained, I managed to select only one variety with superior flavour and complete frost resistance, and two or three secondary varieties. The first variety was derived from crossing Tonkovetka with the well-known foreign variety Beurré Diel.

The savoury round fruit of this variety, slightly below average in size, which I have named Michurin Beurré Letnaya is similar in many respects to the well-known Baltic variety, Beurré Belaya Liflyandskaya, but the trees of the former are much sturdier and their yield is much higher. Almost every fruiting sees them completely covered with clusters of seven to nine fruits each which ripen at the end of the summer. Of the second-class varieties, I shall mention a hybrid obtained by crossing Tonkovetka with the French Saint-Germain pear. The sweet, quite large fruit of this variety

[1] In Michurin's later works this variety is described under the name Truvor.—*Ed.*

matures in the summer, quickly grows overripe, becomes very mealy and absolutely unfit for use. One of our very old varieties of pears, Tsarskaya, is noted for hardiness and productivity. When crossed with the American Idaho variety a quite hardy variety of Bergamotte was produced which I called Andreyev Bergamotte.[1] The dark green round fruits of this variety are very sweet and have a marked tang; the pulp is juicy and there are no carpels or other hardenings in the core of the fruit. It ripens at the end of summer and cannot keep long.

Of the other crosses of the Tsarskaya pear over a fairly long period of time I succeeded in obtaining only one variety, but that a really valuable one for our parts because it is hardy and has good winter keeping qualities. I named it Pobeda; its fruits are average size, bright yellow beautifully tinged with red, and have a sweet, rich pulp which easily keeps fresh till spring. An especially noteworthy thing about this cross is that the general appearance of the aerial parts of the hybrid plant, and in particular its whitish downy leaves, differ radically from both the parent plants, evidently because the parent plants were merely the agents for the hereditary transmission of their own parents' properties to the grandchildren. Of the old Polish cultivated varieties of pears I shall mention Sapezhanka, whose seedlings, when *properly* trained, produce a considerable percentage of variations of the maternal form with fruit of good quality. From Sapezhanka seedlings I have obtained a very good-flavoured variety which ripens before all other varieties of pears; I have named it Bergamotte Novik. A rare quality peculiar to this variety is the ease with which it propagates itself from stool shoots. No changes whatsoever have been observed in the quality of the fruit of trees grown from the shoots. Bergamotte Esperen, a well-known foreign variety, has proved a first-rate maternal plant. The seedlings derived by crossing it with other varieties produced a number of hardy Bergamotte varieties which ripen in the autumn and bear large-sized fruit of quite good flavour. I have one of them down as Russian Esperen.

In addition to the varieties enumerated above, I tried several more of our cultivated varieties, among them Voshchanka, various Limonkas and about five variations of our wild forest pears, but the results of all these experiments were in many respects most unsatisfactory. The fruit of the hybrids and crosses did not develop a good flavour and, in addition, their chief shortcoming was early summer or autumn ripening and lack of storage qualities. As it happens, the most serious shortcoming of our assortment of established varieties of pears cultivated in the orchards of Central Russia is the absence of hardy winter strains. All our old varieties, without exception, ripen early in the summer, spoil easily and are therefore absolutely unsuitable for more or less distant transportation. The result is that they always fetch a very low price on the market. The only pears obtainable in the winter months are winter varieties imported from the South or from foreign countries, and we pay a terribly high price for them. That, too, is why practically all

[1] Later this variety was renamed Surrogat Sakhara.—*Ed.*

Central Russian growers avoid planting a large number of pear trees and confine themselves to a bare minimum of a dozen or so trees, though they do grow a fairly large number of apple and other fruit plants.

This state of fruit growing in our parts of the country prompted me to undertake a long, thorough and persistent search for a variety of pears that would endure our frosts and, when crossed with foreign winter varieties, would produce some hybrids of the hardy varieties of winter dessert pears we need. And, at long last, after many years of unsuccessful experimenting, I finally achieved the goal set. Only in recent years, by employing a variation of the wild Ussurian pear, did I manage to find a suitable progenitor. By crossing this extremely frost-resistant species with the best foreign varieties, I have now obtained several new varieties of winter pears fully capable of enduring our climate; their fruit is of excellent dessert quality. I grew the trees of this wild Ussurian pear from seeds received from northeastern Manchuria and I crossed them the very first year they blossomed. I learned later that the Ussurian pear which I used as the maternal plant, yields small, inedible fruits which ripen in the early summer and spoil immediately after picking. Despite this I obtained three excellent winter varieties of hardy pears from among the first hybrids grown by crossing the Ussurian pear with Beurré Diel. One of them, the Michurin Beurré Zimnaya, was described in my reply to the students of the Moscow Agricultural Institute, published in the first issue of *Sadovod* for this year.

In drawing the reader's attention to the successful results of this crossing, I must point out that in the given combination of propagated plants, the wild Ussurian pear, which was used as the maternal plant, hereditarily transmitted to its offspring only its resistance powers without exercising any particularly negative effect on the properties and qualities of the fruit inherited from Beurré Diel. This is evidently to be explained by the fact that the crossing took place the first year the young Ussurian pear seedling blossomed, before it had developed the potent power of hereditarily transmitting its properties, so marked in all wild species of fruit plants. Besides, in this case the power of hereditary transmission was also weakened by the radical change of environment, in which the young seedling developed, for both soil as well as climatic conditions in our parts differ greatly from those of the Ussurian's native Manchuria. If a wild species of a riper age is used as one of the pair of crossed plants the results obtained are far less satisfactory; this was confirmed when I crossed the same pair of parent plants three years after the Ussurian pear first blossomed, i.e., when it was older. All the seedlings of this crossing bore poor-quality fruit that ripened early in the summer. Apparently the influence of the wild Ussurian pear had grown so much stronger by then that it predominated over the cultivated Beurré Diel's power to transmit its characters by heredity. About eight years ago the seedlings of another natural variety of the Ussurian pear, one with edible fruits, began to blossom in my orchard. This semicultivated, also very hardy variety will, I think, be even more suitable for hybridization purposes in our area; we shall know for certain in the near future. At present, the

seedlings are still young and have not yet begun to bear fruit. It would be extremely interesting to use for hybridization pears of the semicultivated variety called Burakovka[1] which bears fruit with dark-red flesh and has other characters similar to the Niedzwetzkyana apple tree. Towards the end of the 'eighties I procured specimens of this pear from Struss, the Kiev gardening supply firm, which has gone out of business a long time ago.

Fig. 30. Severnaya quince mother tree in I. V. Michurin's nursery (from I. V. Michurin's archives)

Unfortunately, I did not manage to save the trees and they were not listed in Struss' catalogue. Nor did I encounter this variety in the catalogues of other Russian and foreign firms I knew of at that time.

Now I propose to discuss the selection of types of stock for propagating new varieties of pears by grafting. Almost all gardenists, not only the ordinary amateur, but the trained horticulturist too, take the very mistaken view that the kind of stock used for new varieties does not really matter, as is usually the case when reproducing old varieties of fruit plants by grafting. Nothing could be further from the truth. I repeat what I said at the beginning of the article: All long-established varieties have already developed in their constitutions complete stability against diverse outside influences. Hence, they change only slightly or do not change at all, when grafted on to one or another kind of stock. But certain young varieties which are still in the process of acquiring stability of properties may easily succumb to the in-

[1] From the Levitsky nursery.

fluence of the stock and change for the worse, forming a so-called vegetative hybrid with the stock. One must therefore be extremely cautious in selecting stock for young new varieties. Hardly any of the seedlings of wild species of fruit plants, and no adult trees of old cultivated varieties grafted on to wild stock, are suitable for grafting young varieties, and sometimes the latter impair the qualities of the fruit of the young variety even more than the former, because of the influence of the powerful root system of the wild stock.

My numerous experiments show that the best stock for young varieties of pears is quince, because in many cases it improves the flavour of the fruit, increases their size and gives them a good fragrance. A new hybrid variety of quince,[1] more resistant to frost and to the comparative aridity of the soil in our parts, which I bred by crossing the wild Transcaucasian quince with a semicultivated variety from Saratov Province, has proved particularly suitable for this purpose. If the young variety of pears to be propagated is incompatible with the quince stock, which, as all gardeners know, frequently happens when grafting old varieties of pears, then so-called intermediate regrafting with another variety should be employed, i.e., first a variety which grows well on quince should be grafted on to it, and the next year the variety which grows poorly when grafted directly on to quince should be grafted onto a shoot sprouted by the first graft. Satisfactory results can also be obtained by grafting young varieties onto the seedlings of cultivated varieties, chiefly Bergamottes, like Sapezhanka and our Bergamotte Krasny. Adult but own-rooted trees of new cultivated varieties grown from seeds are very suitable for this purpose too. Many hybrids produced by crossing the *Pyrus salicifolia Pall.* pear with cultivated varieties are particularly suitable because of their ramified root system and large number of root fibrils.

First published in 1917 in
Sadovod, No. 3

ALTERATION OF PROPERTIES OF A HYBRID BY GRAFTING ON A GIVEN STOCK

I have noticed on many occasions that when cuttings from a hybrid seedling are grafted for the first time the number of individuals that take is much smaller than in grafts made under the same conditions with cuttings from plants formerly grafted with this variety. The difference is sometimes very great indeed. There have even been cases when the newly-bred variety completely resisted grafting, or only five per cent of the grafts took. Later, however, grafts made with cuttings from these once successfully-grafted individuals yielded a much higher percentage of takings, and this percentage kept gradually increasing in three or four [vegetative] generations of grafts.

[1] Michurin called this variety the Severnaya quince.—*Ed.*

From this it clearly follows that in one way or another the new variety adapts itself, becomes habituated to grafting and, consequently, there inevitably occurs an alteration in it. This seems to be an indubitable deduction, and there is, furthermore, no guarantee whatever that the alteration will not extend also to all the qualities of the fruit in the new variety. That is why a young variety, in the first years of its propagation by grafting, must be grafted on seedlings of superior cultivated varieties.

In general, it is necessary always to bear in mind that in many new varieties of fruit trees raised from seeds the quality of their fruit is perfected only gradually, improving in the course of several years after they have begun to bear fruit, and such improvement can only take place on their own roots or when they are provided with a suitable own-rooted stock distinguished for some outstanding property sought for in the given case, for example, particularly high fertility, large size of fruits, their better colouring, better flavour, or frost-hardiness of the tree. By providing such a stock we can in many cases make good the deficiency of any one of these qualities in the new variety, bend its alteration in the direction we require. Conversely, should we begin to graft a new variety which has not yet attained full maturity on wild stock, the result will quite naturally be that, in the grafted individuals, not only will the development of the qualities of the new variety in the direction of their improvement be arrested, but in the majority of cases these qualities will inevitably deteriorate under the influence of the inferior qualities of the wild stock. I emphasize here the phrase, "in the majority of cases," because it may happen, by way of exception, that some solitary graft will improve its qualities even on a wild host. But this will be a very rare occurrence, and we cannot therefore take it into account. The reason for such an occurrence is an accidentally suitable combination of the properties of the stock with the grafted variety, when the mutual action of the properties of the stock and the scion produces some new good quality in the new variety; for example, the wild stock might have possessed the quality of particularly abundant fertility, even if of fruits small in size, and in the variety grafted on it there might have existed a combination of properties of such a kind that the influence of the wild stock's quality of fertility could be expressed in the grafted variety in an enlargement of the size of the fruits, while the other bad qualities of the wilding might have met with strong resistance, and their action therefore did not manifest itself in the grafted variety. Such chance phenomena, only the other way round, I have even observed in cases of root grafting. A good cultivated variety was used as stock with the aim of inducing a more extensive development of the same new variety in a better direction, but, contrary to expectations, an entirely opposite phenomenon turned up: rather than improve, the variety greatly deteriorated. This, apparently, happened as the result of an accidental pronounced difference in the constitution and properties as between the stock and the scion. I think it may be of interest for the readers to get more details about this rare case which happened in my work, all the more so, since, incidentally, it throws light on other highly interesting phenomenon of which, as usual, there is not a

word to be found in the literature on horticulture. In an exceptionally large and beautiful fruit of a Kandil-Kitaika, a variety which I have bred, all the six seeds proved to be of perfectly round shape, such as may now and then be found in apples of other varieties. The branch which bore this fruit was situated in the midst of dense branches of a neighbouring pear tree. It is possible that this fruit set under the influence of pollen from the pear flowers, owing to which the shape of the seeds changed, although in the outward habit of the seedlings produced from these six round seeds I could detect no character which would incontrovertibly show that the structure of any part of their organism was in any way influenced by the action of the pear pollen.

Besides, it has never come to my knowledge whether mongrels of sexual origin between apples and pears are at all possible. As for vegetative crosses, my observations show that such do happen, even though rarely, as the readers may see from my description of a new apple variety I produced, under the name Reinette Bergamotte, which was printed in the magazine *Vestnik Sudovodstva, Plodovodstva i Ogorodnichestva* for 1907.[1] Now, in the given case I do not at all assert, but merely suspect, that the pear pollen might have exerted some influence in the process of the fertilization of the apple blossom, even if it was fertilized by its own apple pollen, and the result may, perhaps, have been that perfectly round shape of the seeds, which has nothing in common with usual apple seeds.[2] Among the seedlings grown from such seeds sometimes very interesting mutants occur. For example, in 1889 I obtained from a round seed of an Aport apple a seedling with cactuslike shoots, with unusually narrow and very thick leaves; each shoot, the main one as well as those of the side branching, was of the usual round form and thin diameter at the base, but as it grew it thickened considerably and assumed a conical oval shape, a loose structure and light-green colouring, resembling more a cactus than an apple tree. Unfortunately, this seedling was killed by frost in the very first winter, and I therefore had no chance to go on with my observations. I advise others to try the experiment with round seeds of choice large Aport fruits, as I have noticed during repeated experiments the tendency of such seedlings to produce this particular form, although in a much smaller degree. But I have digressed too much from the subject of the article, and I therefore hasten to come back to the description of the seedling grown from the round seed of the Kandil-Kitaika. In the first year of its growth the only peculiar features that could be observed in the form of its parts was in the leaves: they were of a round shape, with a particularly thick blade; besides, the leaves above the cotyledons had practically no serrature, and only in the beginning of the autumn the leaves on the end of the shoot began to show obtuse crenations of irregular shape and of hardly any depth at all. By July of the second year the seedling developed

[1] See pp. 310-14 of this volume.—*Ed.*

[2] In 1917, for the purpose of clarifying this question, flowers of a Michurin Beurré Zimnaya pear were pollinated with the pollen of red-leafed hybrids of a Niedzwetzkyana apple.

a fairly intense growth, with shoot up to 8 mm. thick, of a glossy, almost black colour with numerous spots of a light colouring; the end of the shoot had a somewhat faceted shape and a downy surface, the thick and very wrinkly leaf blades had a dull under surface, their serrature increased and bore an amazing resemblance to the leaves of the maternal plant. I found in the seedling all the characters of a superior cultivated variety and was led by these characters to assume that its fruit would greatly resemble those of the Kandil. In the third year, therefore, in the hope of increasing the size of the seedling's fruit, I grafted several cuttings from it on the crown of an own-rooted and already fruiting tree of a Bellefleur-Kitaika, a variety I bred, which was noted for the particularly large size of its fruits (reaching that of a large Aport), their excellent flavour and great fertility. In brief, all the best qualities were provided for in this choice of stock to improve the young plant. Yet the results were entirely unexpected: the grafted cuttings developed a very feeble growth, with shoots as thin as a match, whereas the green shoots on the tree of the stock, i.e., on the Bellefleur-Kitaika, are nearly as thick as the little finger. The leaves on the shoots from the grafted cuttings were extremely small and of an entirely wild shape. This was a case of complete regressive alteration in the constitution of grafted cuttings of the seedling—the result, apparently, of an accidental combination of too diverging structures in the stock and the variety grafted on it. For the fuller clarification of the causes of the phenomenon I have this summer grafted buds from this seedling on stocks of several varieties, including a pear, and I shall inform the readers of the results.

The above-described case of an intended kind of apple turning out worse in spite of the fact that the stock possessed the best qualities, must, I repeat, be regarded as a pure accident. In the majority of cases, such a method of improvement produces excellent results. In any event, it is entirely up to us to avoid even such accidental failures. All that is necessary is to graft not just on one chosen variety but on several varieties. The failure of a combination in one union will then be compensated in others. No graftings should be made on wild stocks for the purpose of propagation. This applies not only to seedlings of tender age, which have not yet borne fruit, in the case of which there would, of course, be no sense at all in doing so, but also to seedlings of a new variety which have already borne fruit for several years. Only in an extreme case, when absolutely no other suitable stock is available, such a step may be risked, and that only by persons who have enough experience to recognize signs of regressive deviation in the grafts—which, it must be said, is rather difficult; only an experienced person can make a selection by comparing the parts of grown grafts with the corresponding parts in the seedling itself, and even then the selection will not be fully reliable—even with all these precautions the new variety will lose a great deal of its qualities. Nor should grafts be made on grafted adult trees of old cultivated strains, because the wild roots of the stock of such trees will inevitably have a bad effect on the young strain, despite the interposition of the grafted parts of the cultivated variety, as I have had occasion to find out in my numerous experiments. The

strain invariably turned out worse than when grafted directly on a young wilding, still feeble as regards its individual potency.

It is much surer in general, and particularly for beginners, to wait with the propagation of a new strain for five years or so after it has begun to bear fruit. In case of urgency or necessity, young seedlings of cultivated varieties of fruit trees more suitable for the purpose should be used as stocks. For example, from my experience I find that in such cases the best seedlings will be, for apples: large-sized Skrizhapel, Anis and Bely Naliv; and for pears: large-sized Bergamottes and Tsarskaya, and also the quince. Bellefleur may serve as a splendid stock in such cases, only on condition that the seeds are gathered from saplings entirely isolated from other varieties or, at least, with no small-fruited uncultivated varieties nearby. The effect of grafting a new strain which has not yet attained maturity on the crowns of adult trees is worse than that of grafting on young two-year stock, and not only because of the bad influence of the powerful but wild root system; its effect on the qualities of the new strain is more harmful because, when a graft is made on the crown of an adult tree a part of the branches must almost always be left unengrafted, in view of the necessity, as a general rule, in the case of such repeated graftings to try as far as possible not to disturb the balance in the movement of the sap too much by removing at one stroke a large number of branches as compared with the size of the root system, since this is very injurious to the health of the tree and often may even kill it.

In the regrafted tree there thus manifests itself the undesirable action of the leaves of the old cultivated variety, or, still worse, of the wild stock, on the transformation of sap; and this, naturally, has a highly pernicious effect on the grafted parts of the young strain, as it misdirects the work of its leaves. This harmful effect is precluded when the graft is made on young stocks, because the latter have no branches at all.

When seedlings of hybrids or crossbreds of fruit plants from the union even of several delicate varieties are reared in our regions, quite hardy individuals are often produced, because from the earliest stage of its development such a seedling becomes accustomed to the climatic conditions in our regions and adapts itself to them.

An example: Bellefleur and the Niedzwetzkyana apple, which are not hardy enough in our regions, when they were united, produced sufficiently hardy hybrids. Resistance can be obtained even more surely, if some of our hardy varieties have taken part in the fertilization or if the seedling has been subjected to the action of a hardy mentor, i.e., underwent vegetative hybridization.

By way of a test, cuttings of Pippin Shafranny were grafted on four-year-old seedlings of a large Strelnikov Aport in the spring of 1916. They were inserted in short stumps about an inch thick. The purpose was to increase through the action of such a mentor the size of the young strain of Pippin, which was bearing fruit for the first time, and, incidentally, to observe the influence of the stock on several individuals. Already in the first summer of

growth one graft showed signs of a special influence: its branchings from the main shoot had at their bases clearly noticeable bulging rings, resembling a muff.

I have often come across such a phenomenon also on wildings overnurtured for use as stocks.

When taking cuttings from the mother tree of a new strain for the first propagation by budding in the summer, extreme care must be exercised in regard to the number of cuttings taken, which must under no circumstances exceed one-fourth of all the shoots on the tree; for if a larger number of cuttings are taken, particularly in rainy weather, the tree may inopportunely begin to develop a new growth, with the result that it will be caught in the autumn frosts before it has completed its growth—in full sap—and will inevitably be injured by them. In spite of the new strain's fully formed hardiness, the tree may be seriously injured by the frosts both in the given year and in the next one, because, having lost the frozen portions of the crown, it will develop an excessive growth the next summer, owing to which the young accretion will again remain unmatured by the autumn and will again be injured by frosts. In this way the strain may lose one of its most valuable merits—frost-hardiness. This is particularly true of new kinds with late winter maturation of the fruits, because all trees of such winter varieties tend, as a general rule, to complete their vegetation period late in the season. The harm will be still more serious if the immoderate removal of cuttings is repeated several years in succession. In such cases, owing to the extremely harmful influence resulting from the interference with the sap movement in the plant, the new strain almost always loses its hardiness and becomes unfit for cultivation in this locality.

The removal of cuttings for grafting in the spring is not so harmful as in the summer; nevertheless, in this case too the number of cuttings taken from the tree should not be too large. It is best to take summer cuttings as late as possible in August, because there is less danger then that the tree will begin to develop growth for the second time.

Improving the qualities of a seedling by action of a mentor when still in its first year. There are cases when it is possible to achieve better results in inducing vegetative changes in the qualities of the seedling by supplying the influence of a mentor at the seedling's earliest age. Here is an example: I used the pollen of a Niedzwetzkyana apple to fertilize a new kind of Pippin Shafranny. In the five seedlings which sprouted next spring, one was with dark-red leaves. Now, knowing the general tendency of seedlings of Glogerovka to yield fruit of small size, and desiring to eliminate this defect in the future new strain, I used the red-leafed Pippin in the first year of its growth, on July 13, before there was any sign of future buds in the leaf axils of the seedling, to make three buddings on the still green shoots[1] of that same

[1] Such graftings can only be made on shoots of the same summer, with a thin bark, because the cut shields are still very soft and cannot be inserted into the thick bark of the stock.

summer's accretion of a Bellefleur-Kitaika tree, which is distinguished by the specially large size of its fruit, reaching that of the Aport. Of the three graftings, one stood out most sharply because of the fact that by August 12 it developed a bud of unusual length, nearly 7 mm., of a pointed conical narrow shape, and of dark-red colouring. The shields of the other two grafts, although they adhered, formed no buds at all.

Towards the middle of the autumn the buds formed on the seedling itself were of the usual size and shape, as in all cultivated varieties of the apple. Consequently, the mentioned long bud of the successful graft with its shape unusual for an apple owed its appearance to the influence of the mentor stock upon its still very feeble embryo in the leaf axil of the budded shield, and represented a new kind of vegetative hybrid, different from the seedling. And this was indeed borne out by later developments.

In the first two or three years after the young strain has begun to bear fruit, only those fruits should be left which set closer to the base of the branches, because they are almost always larger and more perfect; and by preventing the setting of smaller-sized fruits which are usually to be found at a longer distance from the stem and from the base of the branches, the tree of the new strain will be prevented from giving less-developed fruits.

A cold and rainy spring and summer strongly affect the development of the size of the fruits and the time of ripening. In some strains the size is considerably reduced and the ripening is considerably retarded. Many strains of apples become juicy from the excess of moisture, and this is a serious shortcoming in winter strains, because it makes the fruits less capable of keeping fresh in storage. Such fruits usually become quickly spoiled, not only in their fresh state, but also in soaking, because their skin comes off and the pulp becomes crumbly.

Good qualities, in the majority of cases, do not immediately appear in new strains, but develop gradually in the course of several years after the first fruiting. The size and flavour of the new strain Kandil-Kitaika, for example, developed only in the course of ten years after the first fruiting. The fruits of the new strain Bellefleur-Kitaika acquired their Calville-like shape and their ability to keep fresh for a long time in winter storage only after the first three years of fruiting. The same holds good for stone fruits and berries: the size of the fruits of cherries, plums, currants, gooseberries and strawberries is at first almost always imperfect; only in subsequent years it gradually increases until it reaches the standard.

In breeding new strains of fruit trees the main point is not in the process of artificial crossing, which, in the words of Rytov, a child can perform, but, firstly, in discriminative mating of the pair of plants, and, secondly, in an altogether special method of rearing the seedlings until they begin to bear fruit and during the first five years of fruit-bearing—a method of which not only our ordinary horticulturists, but even highly qualified ones, have a very hazy and sometimes even utterly wrong idea, because of a lack of practical experience in this matter.

The capacity of some new strains of fruit plants to breed true when propagated by seeds and also by layers. Among new strains of fruit plants we may find also such, the seeds from the fruit of which will be endowed with the property of constancy.

Such a property is particularly valuable in young strains, even if it is at first manifested in a small percentage of all the seedlings, because subsequently, upon the young strain attaining maturity, the percentage of seedlings that breed true is sure to increase a great deal. In the seedlings from the seeds of the young strain's first fruiting the degree of their constancy can be ascertained only when they are at least three years old; prior to this age the characters of the maternal plant are very indistinct and little discernible.

Besides, it is necessary to watch plants of young strains with a view to noting the tendency of some of them to give root growth or even only shoots from the lower part of the root neck. Many such strains can subsequently be easily propagated by root cuttings.

Lastly, there are strains more or less capable of being propagated directly with cuttings from the shoots, like an ordinary willow or poplar.

The long-known apple called Orbaiskoye, or Verbnoye, is an old strain of just such a kind. Unfortunately, among the new varieties I have bred, one which had these properties well developed was utterly unfit for the role of stock because of the inferior quality of its fruits, and I had to destroy it. Only quite lately have I found that the excellent, large-fruited Bellefleur-Kitaika manifests—though in a very slight degree—the above-mentioned properties: a capacity for the rooting of cuttings both from shoots and, particularly, from the roots. It will be necessary to try, by repeated rooting of its cuttings in the coming years, to accustom it to this process and thereby enhance and perpetuate this property in the strain. Here I consider it necessary to affirm most emphatically that it is infallibly possible to habituate a young strain to the mentioned process of propagation by cuttings from shoots or from roots, as well as in general to all other processes useful for the horticulturist. In such cases, the annual repetition of the methods applied in these processes becomes, as it were, a habit with the organism of the plant of the new strain, and, with each passing year, the percentage of success increases. For example, the capacity for good adhesion of eyes in budding or of cuttings in whipgrafting also develops gradually in about four years of successive graftings, and each time the cuttings are taken, not from the mother tree, but from the specimen grafted the previous year.

The same method should be applied in the process of propagation by rooted cuttings, both those taken from the root and those taken from the shoots [the stem]. Of course, such a property can develop in each given strain only to a certain degree. Still, this can be of great benefit to horticulture, because it may be possible to find among the new strains such as can be easily propagated by cuttings on their own roots without thereby losing their good fruit and growth qualities, and thus provide the opportunity even for many non-specialists in fruit growing to grow an orchard of such strains.

Breeding new special varieties for stock. As a corollary to the main task of producing from seeds new strains of fruit plants with the best possible qualities of their fruits, observations should be conducted and a choice made of seedlings with indications of outstanding useful properties of their root system, as a consequence of which such specimens may yield new valuable kinds of stock. Unfortunately, none of our horticulturists pays any attention to this. Nor is this surprising, because so long as they are not engaged in the practical work of breeding new strains from seeds, horticulturists have no opportunity to get acquainted with the diverse peculiar features both of the aerial parts and of the root system of plants which every attentive originator often comes across. A graphic example is provided by the following fact out of my experience: while rearing a hybrid seedling obtained from a cross between the well-known American apple Bellefleur and *Prunus prunifolia* of our orchards, I noticed that after each of the three times it was transplanted, at three different ages, the seedling, far from being in the least retarded in the development of its growth during that year, developed a particularly luxuriant growth, and did so simultaneously with its non-transplanted brothers.

Such a property is the result of a specially rapid development of new root fibrils and their fast and vigorous activity in the case of this strain, which is in general distinguished for its luxuriant and vigorous growth, coupled with unquestionably complete hardiness to the winter frosts in our parts.

On account of all these properties taken together, we have every reason to regard this hybrid of a Bellefleur with the Kitaika, not only as one with first-class fruit qualities, but as the best stock for many cultivated kinds of apples in our orchards. Such a stock, propagated by root cuttings, will be particularly useful to originators for initial propagation of new kinds of apple trees just bred from seeds. It is simply unrivaled as an ideal nurse, because the young strain grafted on it is least of all subjected to the risk of regressive deviation resulting from the harmful influence of the root system, which is often the case when wild species of apples are used as stocks for young strains which have not yet developed sufficient stability. Of course, in very rare exceptional cases individuals may be found in the new strains which, in spite of all the merits of the described stock, will manifest a negative attitude towards it; but, I repeat, this will be a rare case and may be disregarded.

Thanks to its outstanding ability easily to stand transplantation both at a young age and also at an older age, as compared with ordinary types of stock, this variety is a very valuable acquisition both for nurseries and, no less so, for orchard owners. Besides considerably reducing the risk of injury to trees, or of their complete destruction, during transplantations, this stock will make it possible safely to transplant, or plant orchards with saplings that are much older than is the accepted rule with ordinary stocks; and this is a very important point, if only for the reason that, with very few exceptions, almost everyone who plants a fruit tree wants it to bear fruit as soon as possible. As for the opinion, accepted by many, that stocks of wild species of

fruit plants, owing to the greater frost-hardiness of their roots, impart greater hardiness also to the trees of the cultivated strains grafted on them, as compared with trees grafted on seedlings of our cultivated varieties, it is only borne out in the case of a few of our local orchard strains, but certainly not of all of them. For example, the roots of seedlings of Anis, small Skrizhapel and ordinary Antonovka, to say nothing of the diverse varieties of *Pyrus prunifolia* of our orchards and its numerous hybrids, are not only in no way inferior to wild apples as regards the degree of their hardiness, but in some cases they even surpass them in respect of hardiness to the frosts in our regions.

1917 (?)

ERRONEOUS OPINION OF MANY LEARNED INVESTIGATORS CONCERNING THE POSSIBILITY OF VEGETATIVE HYBRIDS[1]

It may definitely be presumed that Vöchting, Molisch, Kerner and other investigators well known for their works have been too one-sided in their study of the possibility of the phenomenon of vegetative hybrids among plants in general and, particularly, among orchard fruit trees. The named scientists either doubt or absolutely deny the possibility of vegetative hybrids. But this view only shows that their knowledge of plant life is too superficial. Contrary to their opinion, I categorically assert, on the basis of many years of observation, that when parts of plants of two different forms, and particularly of two different species or genera, are united by grafting, we almost always, with rare exceptions, observe the appearance of alterations in the structure of the united parts, with a dominating deviation towards the one of the two united forms whose constitution possesses greater stability that either developed by chance or was acquired during many years of existence under relatively unchanged environmental conditions. As a matter of fact, this is an indefeasible law, not only fully analogous to the phenomena observable in the case of sexual union of various plant forms, but in some cases even more so. (I will go even farther: We are here directly confronted with one of the details of the universal struggle of organic forms for their existence.) To explain the doubts in, and, still more, entirely to deny the possibility of, vegetative hybrids only on the grounds that in practical horticulture cultivated plant varieties grafted on different kinds of stock undergo no *perceptible* change, is, to say the least, too naive. In the first place, an alteration always, with rare exceptions, does occur, even if in a slight degree noticeable only to a keen and experienced observer—the slightness of the alteration being due entirely to the fact that, in the combination of the two plant forms, one—the scion of

[1] **A lecture delivered by Michurin at a district agronomic conference in the town of Kozlov (now Michurinsk) in 1922.—*Ed.***

the cultivated form, taken from an old tree which has borne fruit for a number of years, and which came from a long-standing variety into the bargain—possesses such a long developed power of stability that the young, and therefore weak, two- or three-year-old stock (wilding) is naturally unable to overcome it. That is the reason why the alteration of the grafted varieties is very slight. Secondly, cases of pronounced and considerable changes in ordinary grafts are not really so rare as to be unobservable or disregarded, at least by people who know something about horticulture. . . . Now, here is my suggestion to the indoor botanists: instead of poring over the grafting of beetroots, potatoes, etc., take the trouble, gentlemen, to graft some cultivated, large-fruited apple variety on the crown of an adult wild apple, for example, the Siberian crab, and wait for the stock to begin to bear fruit—you will then see for yourselves an alteration so pronounced as to make it entirely impossible to recognize the variety by the fruits that have been produced. After such an experiment, your eyes, I hope, will begin to notice the alterations which occur in all grafting combinations ordinarily employed in horticulture. I anticipate that you will raise the following objections. One objection—that in the example cited the cause of the alteration might have been the exceptional inadequacy of the nourishment supplied by the Siberian apple to meet the requirements of the large-fruited cultivated variety. But this is wrong. You may prune many of the branches of the Siberian crab, and direct most of the sap to the grafted branch, and yet you will not restore the variety. The cause here is not the inadequacy of nourishment, but the fact that the stock, the adult Siberian apple tree, possesses almost the same individual, and quite stable, power of influence as the cultivated variety grafted upon it, and the result is therefore a cross. Another objection on your part may refer to the relative instability of the alteration of the grafted variety when its parts are transferred to other stocks, owing to which it cannot be regarded as a hybrid. Granted that in the particular case there may seem to be a grain of truth in this, but in general such a deduction is obviously erroneous—firstly, because any hybrid obtained by the sexual method is just as unstable in the early stage of its development, in the first two or three years, and may likewise change if it is not allowed several years to develop the property of stability; yet you will not on this account venture to deny that it is a hybrid. And, secondly, if the vegetative hybrid mentioned above is kept for a longer period under the influence of the adult Siberian apple tree, of its leaf and root systems, it will also acquire complete stability. For the fuller clarification of the misunderstanding here discussed, I shall cite a few facts from my experience:

1. When I obtained the new 600-gram Antonovka, I grafted one cutting each of the new sport onto the crown of an adult Siberian crab apple tree and on a two-year-old seedling of a Skrizhapel. After a few years, the branch of the Antonovka sport which developed from the graft on the Siberian crab bore fruit of less than medium size, of a perfect cylindrical shape, and with a distinctly tart flavour. Apart from the white colouring of the skin, it had nothing in common with the sport. On the other hand, the engrafted

Skrizhapel seedling bore fruit much later, and here not only was everything identical with the original, but the size became even larger (the influence of a stock superior in all respects).

2. A hybrid produced by crossing a Winkler White Cherry with a Vladimirskaya sour cherry, which I have named Knyazhna Severa, bore large drupes of a pure white colouring; but, when propagated by grafting upon seedlings of orchard cherries, the drupes, although their size remained unchanged, acquired a bright pink colouring (the pigment acquired through the influence of the stock).

3. Cuttings of the Moldavskaya Krasnaya pear (or Malikovka) grafted onto the crown of an adult and already fruiting tree of a hybrid seedling of a Sapezhanka pear, not only became altered themselves and bore fruit twice the size and of a more elongated shape, but also altered the shape, the size and the maturation time of the fruits of the Sapezhanka seedling; the fruits of the latter increased in number, but their size shrank by a half, the shape changed from round to oval, and the period of maturation lengthened by two weeks (the mutual influence of the stock and the grafted variety).

4. A hybrid seedling of an Antonovka, when still only one year old, was bark grafted on a pear-tree offshoot. In spite of the unsuitable stock, it developed excellently and bore apples of a perfect pearlike shape with the same shades of colouring, an excellent spicy flavour, and ripening in storage towards the end of October. However, scions from it, grafted upon apple stocks, produced fruit, although of as excellent a flavour, but their pearlike shape was lost; the only features it retained were the complete absence of any cavity at the base, where the stalk is attached to the fruit, and the dark-green colouring of the place usually occupied by the cavity. The ability to keep fresh extended to April. (A vegetative hybrid of an apple and a pear and its alteration under the influence of the apple stocks.)

5. In the propagation nursery, in a row of seedlings of the wild forest pear budded with the Bessemyanka pear, one of the grafted specimens singled itself out from the very first year of its growth by the specially close situation of buds running the entire length of its one-year shoot, while the other specific characters of the grafted variety of the Bessemyanka pear—the shape of the buds and of the leaf, the colouring and the thickness of the shoot—were not altered in the least. I surmised that the type of growth acquired by the graft was due to the vegetative influence of the stock, which happened to possess a great individual potency in transmitting its properties, and I transplanted the specimen from the row to a permanent place for further observation. And, indeed, the tree that grew up bore fruit which, although they were quite typical as regards size, shape and colouring, not differing in this respect from the Bessemyanka, proved to have an unusually hard and absolutely inedible pulp. This bad quality was apparently transmitted to the vegetative hybrid from the wild forest pear stock. Here, incidentally, it should be noted that in order to prevent the accidental propagation of such degenerative deviations in grafted varieties of fruit plants, cut-

tings for grafts should never be taken from young plants which have not yet begun to bear fruit.

6. In the beginning of last summer, 1921, with the deliberate intention of producing a vegetative hybrid, I bark grafted on a two-year-old seedling of an orchard plum a cutting from an *Amygdalus nana var. mongolica* at the earliest stage of its development after germination, when it only had three leaves. (Of course, in view of the extreme delicacy of the young cutting and its small leaves I covered it with a glass jar and shaded it on the sunny side by coating the inside of the jar with a thick solution of chalk.) The result of this union was not long in coming. Under the influence of the action of the plum leaves that were left on shoots of the stock, and of its root system, the entire habit of the *Amygdalus* shoot sharply changed as compared with the newly grown shoot on the seedling from which it had been cut; the shoot became thicker, the leaf blade, owing to the considerable expansion of the parts close to the midrib, became trough-shaped, the pointed and deep serratures of the leaves grew rounded and their depth decreased. All this, undoubtedly, goes to show that it is possible to obtain by the vegetative method hybrids not only between varieties of the same species of plant, but also between different species and even genera, which is in many cases impossible to achieve by the sexual method.

That vegetative hybridization is undoubtedly possible, is a question which I consider definitely settled. But, apart from this, it becomes evident from the enumerated facts that, under the prolonged influence of stocks of various wild forms, particularly under the influence of the Siberian crab apple which has been employed as stock for the past half century, coupled with the gradual exhaustion of the soil in orchards and the lack of proper care, many of our old, long-standing fruit-tree varieties have in the majority of cases strongly deviated towards degeneration and have become enfeebled, owing to which they serve as favourable ground for the mass development of various parasites. The latter have lately multiplied so overwhelmingly that, despite the application of all sorts of measures, including sprinkling with arsenic solutions, they defy the efforts of horticulturists to bring them under control. The productivity of the varieties and, hence, also the income from orchards has been dropping from year to year.

The most energetic measures must be taken to prevent such an outcome, which would be extremely detrimental to the whole state. The most effective measure is to refresh and replenish the assortments of fruit plants by the introduction of new, more productive strains bred under the influence of the more recent climatic, soil and other conditions of the environment in our regions. Every inhabitant of Russia—a country largely agricultural—ought to understand and be fully aware of the fact that each new variety introduced into culture in our orchards, if it yields a few score rubles more income than our previous strains, will, when spread over several provinces, mount up to millions of additional income in Russia's agriculture. The latter conclusion applies in practically the same way to our cereal crops. Let us take, as a graphic example, the constant poor yields of buckwheat in our

regions. It is asserted that nothing can be done about this, because the climatic conditions in our regions are unsuitable for buckwheat....

But is it really so? Granted that the two or three buckwheat varieties at our disposal are indeed unsuitable; but why then should we not breed a new variety of buckwheat which would be quite suitable for cultivation in our fields? In my opinion, the error committed in this matter consists in the fact that the seeds used are for the most part such as were gathered in a good year or, to make matters still worse, these seeds are selected and only the best of them set aside for sowing—in line with the popular proverb: "As you sow, you shall mow." But in the majority of cases such seeds, gathered from the crop of one of the rare years which happen to be favourable for buckwheat in our regions, do not bear out the proverb. They are unable to withstand the rigours of the climate and perish. At the end of the past century our farmers displayed a ridiculous naivete when they put their faith in advertisements which praised Sakhalin buckwheat. Completely overlooking the sharp difference between the always moist marine climate of Sakhalin and our thoroughly continental arid regions, they made the mistake of pinning their hopes on the imaginary hardiness of this variety of buckwheat, and, of course, were deeply disappointed, because it proved to be even less suitable for us than our old varieties. An entirely different result could be achieved if a new variety, hardy to our climate, were bred. To produce such a variety it is necessary to take the seeds, not from the crop of a good year for buckwheat or, still less, from those selected on our experiment fields, but, on the contrary, they should be carefully gathered from those rare specimens which held out in the struggle, became adapted to the unsuitable climatic, soil and other conditions, survived and bore fruits in a year of the poorest possible buckwheat harvest. Such seeds sown the next year will yield a much larger percentage of specimens that have survived, whose seeds, in their turn, when gathered in an unfavourable year, will still further increase the number of hardy specimens, etc. By such means a new variety of buckwheat, quite enduring in our regions, will develop in a few years. The same must be said of the measures to be employed against poor harvests of cereals due to drought, the more radical of them consisting in breeding new drought-resistant varieties....

I repeat again, in conclusion, that it is extremely unreasonable and very dangerous stubbornly to stick to the old in everything and everywhere. Everything in life steadily and constantly strives to move onward, and every part that lags behind in the general movement is inevitably destined for destruction. In agriculture, too, it is therefore necessary by all means and in everything to strive for improvement in general and, in particular, to augment our assortments of fruit plants and cereals with new varieties, such as are more profitable and in quality more fully meet the requirements of life today. Everyone should therefore know and firmly remember that the breeding of new, improved varieties of fruit plants is not an idle occupation, as some conservatives think, but a very important and highly useful work, which should receive every attention and sympathy.

1922

HOW THE SUCCESS OF HYBRIDIZATION MAY BE FACILITATED

Ever since 1898 I have, in some cases, employed the following method in attempts to cross plants of two different species and, moreover, two genera. I have transferred a particle of the cellular tissue of the stigma and its secretion (of an acid reaction) from the flower of the male parent to the stigma of the pistil of the female parent, because this method promotes the germination of the pollen tubes and their penetration into the tissue of the female parent of the other species or genus. This operation is best performed with a wedge-shaped retouching pencil (such as used by photographers). As far as possible the transfer of the bit of cellular tissue should be performed quickly and in the morning hours, when the air is moister. Besides, it is necessary to protect the bit of tissue from the drying action of wind (if it cannot be conveyed during a period of calm). However, there is no reason for being particularly worried about the vitality of the transferred particle, if only because it is the specific odour of the secretion that plays the principal role in this matter, and, as has been stated, "this cellular tissue, even when boiled, i.e., killed, still attracts germinating pollen tubes."[1]

When the blossoms are of small size, it is enough to transfer a particle of the secretion of the stigma, which is best accomplished by merely rubbing the pistil of the plucked blossom of the male parent. K. A. Timiryazev is hardly right in the statement quoted above. I repeat that the most likely explanation is that it is not the cellular tissue in itself, but its specific odour, which does not disappear, even in boiling, that attracts the kindred spermatozoids. This is borne out by analogous phenomena in the entire animal kingdom. And, if many cases of failure are still observed even when this method is applied with the utmost care, such cases are due to the unsuitable composition of the nourishment of the pollen tube during its penetration into the tissue of the pistil. In such cases it is perhaps better to reduce the length of the pistil to the possible minimum and then to inoculate the pistil with the stigma of the male parent by grafting.

1923

CROSSING PLANTS OF DIFFERENT SPECIES

In cases when plants of different species obstinately refuse to unite in mutual fertilization, it is always necessary to prepare such plants beforehand for the act of sexual hybridization. Such preparation consists in first producing vegetative unions and only then crossing the plants sexually. In order

[1] I. V. Michurin refers to the following passage in K. A. Timiryazev's book, *The Life of the Plant* (Sabashnikovs, Moscow 1914, p. 221): "However, there exist observations to the effect that pollen tubes, germinating under the microscope, make their way towards the bits of tissue of stigma or style placed near them. This tissue apparently exercises its action even when it has previously been killed by boiling."—*Ed.*

to produce a sexual hybrid in these cases, from five to ten one- or two-year-old seedlings of both the male and the female parent plants should be taken and mutually joined by budding in the summer or by whipgrafting in the spring. The successful specimens should be used in the next season for grafting on to the crown of older—5-10-year-old—stocks. The shoots of such engrafted stocks should not all be removed as is usually done in ordinary grafts, but a number of shoots equal to that of the grafts should be preserved until fruiting time, i.e., until the beginning of blossoming on the twigs of the stock and the scion, and then the cross between the two is effected. This operation is much more likely to succeed in such cases, because by the time the crossing is performed the plants have developed a mutual affinity in their vital functions. The seedlings obtained from the sprouting of the seeds from such hybrid fruits already represent real hybrids of plants of two different species, and the seeds of such hybrids are almost always quite normally developed, giving a fair percentage of germination. Furthermore, a large number of different variations appear in the second generation.

By this method combinations of the following plants may be obtained: apple with pear, *Amygdalus* with plum, *Amygdalus* with peach, apricot with plum, bird cherry with sour cherry, mountain ash with pear, apple with hawthorn, quince with pear. *An infinite prospect opens here for the possibility of obtaining entirely new species of fruit plants with unprecedented forms and properties.*

1923 (?)

THE PROCESS OF APPROXIMATING TWO PLANTS OF DIFFERENT SPECIES BY THE VEGETATIVE METHOD FOR THEIR SUBSEQUENT SEXUAL UNION

To obtain new species of fruit plants for the purpose of raising the qualitative level of their assortments the crossing of plants of different species must play an important role in every locality; until recently, however, cases of such a union have been very rare, and botanists have regarded plants produced in this manner as mutations arising from unascertained causes. Indeed, the sexual union of plants of different species such as, for example, apple with pear, pear with quince, pear with mountain ash, plum with apricot, cherry with bird cherry, plum with cherry, and so forth, has been regarded by botany as, if not an impossible, then at all events as an extremely doubtful phenomena, and extremely difficult to achieve artificially. And yet, even a most superficial glance at the origin of the numerous species and genera in the vegetable kingdom will make it perfectly clear that one of the chief causes of this is precisely the intercrossing not only of individual species, but also of the different genera of plants and their tribes that have accumulated during the course of the many millions of years that plants have existed on earth. It would be wrong, of course, to deny the great influence played in this matter by the changes that have taken place in the course of numerous centuries in climatic and soil condi-

tions, changes, which, although extremely slow, nevertheless unceasingly serve as a force, auxiliary to the first-mentioned cause, for altering and producing new species and varieties of plants. Unfortunately, in producing more and more new varieties of plants in this way, nature pursues only its own aims and mission, by no means in harmony with the needs and wishes of man, who was obliged to use already available varieties of plants that chanced to meet some or other of his requirements and to improve their quality in the direction he needs through selection and by all the means of cultivation suitable to his wishes.

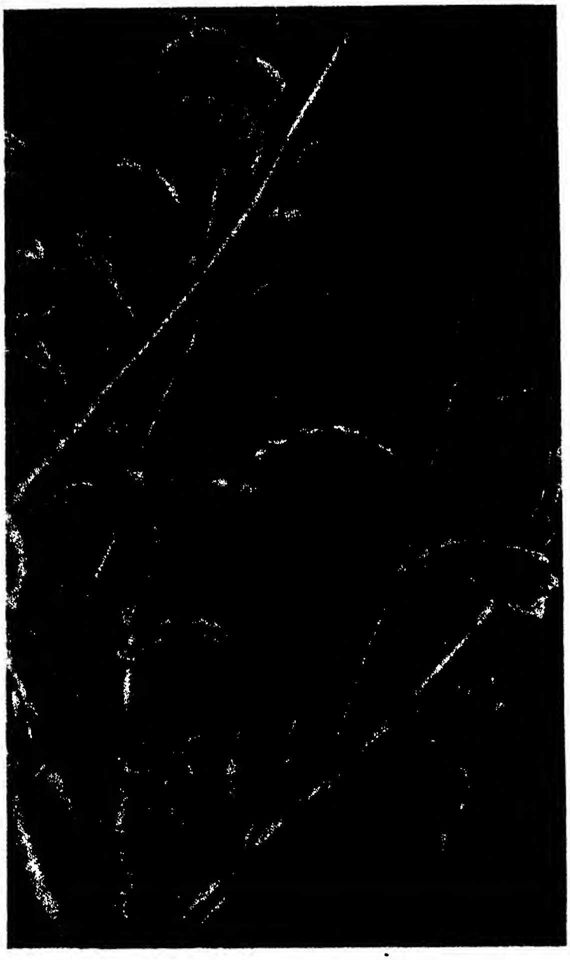


Fig. 31. Vegetative approximation for sexual crossing: stock—hybrid Bellefleur-Kitaika apple, scion—Michurin hybrid mountain ash (from I. V. Michurin's archives)

And so, it was only by these means that all our assortments of fruit plants were collected; in the overwhelming majority of cases we have used only those varieties of plants useful to us in one way or another which we found by chance; so it has been in the past, but now, when man, in the course of his evolution, has reached a higher stage of his development, he can no longer be dependent on chance, he is not satisfied with using the doles of Nature, which is blind to his needs. The time has come when man is able not only to produce the lifeless mechanisms of different machines, but also to create living organisms of new species of plants, and in the future, probably, will also be able to create new species of animals more useful for his existence.

The object of my present article is to expound, as far as possible in the simplest and most intelligible form for all, the best methods of producing not only different varieties of a given species of fruit plant, about which I have already long ago written many articles, but also of artificially creating entirely new species and races of plants from which man will in the future obtain, by selection, not only

improved assortments of fruit plants for his nourishment, but also better varieties and species of plants for different technical purposes, and, what is particularly important, in this way obtain new varieties of medicinal plants, many of which will successfully replace in our pharmacopeoia the old varieties that have completely lost their healing powers, the latter being the inevitable result of changes in climatic conditions and natural degeneration.

1924 (?)

INTERSPECIFIC HYBRIDS. CROSSING SQUASH WITH MELON AND CUCUMBER

While it is on the whole easy to cross plants belonging to variations of the same species, plants of two different species are rather difficult to cross; still, by persistent repeated experiment, I have succeeded in obtain-

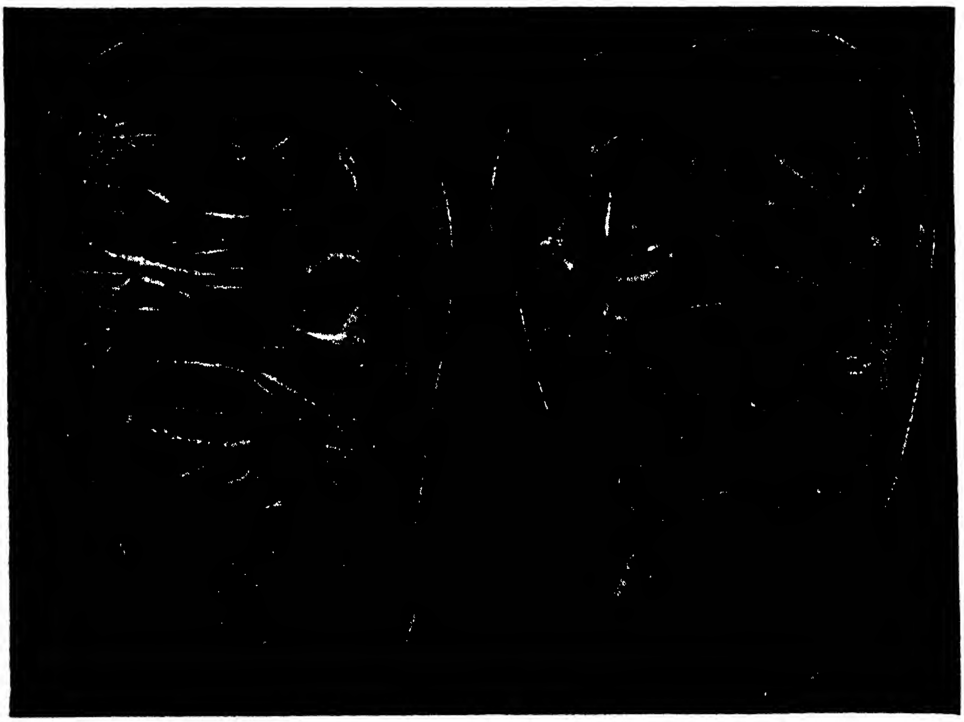


Fig. 32

ing fairly satisfactory results in this respect, and some highly interesting facts have come to light in the process.

Thus, when the flowers of a runnerless bush squash (*Cucurbita pepo*) were fertilized with pollen from an early-ripening melon with a vegetative period of fifty days, most of the setting fruit developed normally for forty-

fifty days, but then their growth ceased and after a short time they spoiled and rotted without reaching complete maturity and proper seed formation; only rare isolated specimens, apparently deviating in their nature entirely in the direction of the squash, attained maturity normally, kept until midwinter, and produced germinable seeds. There were no marked changes in the structure of the flesh or, particularly, in the appearance of the seedlings the following year—only that the flesh was of somewhat softer texture and more sweetish flavour. Since the fertilized flowers had been meticulously castrated at a suitably early date, and since after pollination they had been guarded carefully against the entry of squash pollen, one necessarily suspected that these fruits were the result of parthenogenetic development of the egg cell; but when the second, third and fourth generations of the hybrids were raised, fertilization with melon pollen being repeated each year, the number of fruits attaining full development increased considerably, and the whole flesh layer assumed the form of noodlelike strings spiralling down the fruit; these string-skeins unwind easily, starting at the top of the fruit, going down and ending at the top again. In dried form, these strings keep well and are very palatable in soup or as a vegetable with roasts. The fruit has a firm outer rind three millimetres thick. I append a photograph of a vertical section of such a fruit, with the whole structure of this noodle squash clearly visible (see Fig. 32).

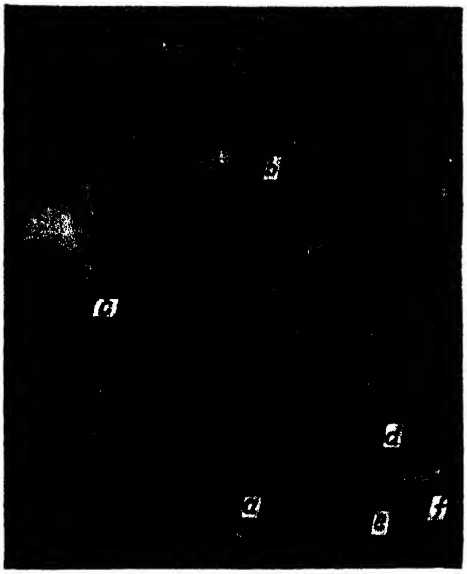


Fig. 33

As another case in point, let me quote an instance when plants of two species were crossed following preliminary vegetative approximation by grafting. The experiment was carried out on my instructions by my assistant, Comrade Gorshkov. The way of it was as follows:

Seeds of the Nerosimy cucumber were planted in a hothouse frame on February 24, 1924; they sprouted on February 28. On March 15, for purposes of vegetative approximation, sprouts of the hybrid noodle squash and of the Kommunarka melon were grafted respectively onto the axial shoot and the two main branches of the cucumber plant. At the time of grafting, the cucumber plant had five leaves, while the squash and melon scions had only fully developed cotyledons. The stock and scions joined very quickly, the grafts soon began to grow and developed runners, which, after being pinched off above the third leaf, produced flowers by May 20.

These were fertilized after careful castration—twenty melon flowers with squash pollen and twelve squash flowers with cucumber pollen.

Of this number, only one melon flower and one squash flower successfully produced a fruit on the cucumber-runner as stock. As the fruits developed, the melon ovary deviated greatly from the maternal form: the resultant fruit was small, green in colour and of conical shape, coming to a point at the calyx end. It contained thirty-one seeds of peculiar bevelled form. In the case of the squash fruit, the only manifest change was that it was half the normal size, with forty seeds circular in shape and also of half the usual size.

I append a photograph of the plant in this experiment (see Fig. 33). The letter *a* marks the cucumber stock, *b* and *d* the melon scions, and *c* the squash scion.

The results obtained by planting these seeds next spring and summer I shall communicate in due course.

In my next article I shall describe hybrids of the sour cherry and bird cherry and of mountain ash and pear.

First published in 1925 in
Agronom, No. 4

THE RESULTS OF FORTY-SEVEN YEARS OF WORK ON HYBRIDIZATION IN THE FIELD OF FRUIT GROWING

In compliance with the request of the Department of Applied Botany and Selection of the All-Union Institute of Plant Industry sent to me by Professor N. I. Vavilov dated September 1, 1922, No. 1915, I am sending a brief summary of my work for the past forty-seven years on the production of new varieties of fruit cultures for the improvement of the assortment extant in Central and Northern Russia.

First of all I shall say a few words about the necessity of improving and renovating all of our much too antiquated agricultural varieties.

Centuries have passed, and we are still where we were from time immemorial.... In the meantime, all that we can call our own has become antiquated, and fails to meet present-day requirements, while the majority of what we borrowed from our neighbours has proved to be of little use due to our local climatic conditions. I shall say nothing of the quality of our grain crops. Let us turn our attention to local horticulture which is an important branch of our agriculture. What is the assortment of orchard culture that is spread on the vast areas of Central and Northern Russia? Everywhere we find the traditional Antonovka, Anis, Borovinka, and the various kinds of Plodovitka, Terentyevka and other archaic rarities. That is so far as the apples go; as to pears, cherries and plums we have even less than that: only the popular Bessemyanka, early-ripening Tonkovetka among the pears, Vladimirskaya among the cherries, and half-wild damson and wild blackthorns representing our plums, with an occasional foreign Reinette here and there scattered among the orchards.... It is impossible to expect decent

productivity from such a miserable assortment under present-day conditions. Besides, we have vast regions such as the Urals and Siberia where up to this day only wild forms of local fruit cultures grow in the forests and practically no cultivated varieties are to be found.

At the very onset of my work in the field of horticulture (in 1875) this state of affairs induced me to look for means of augmenting our assortment with varieties of higher quality, a task which seemed to me quite easy to fulfil, as at that time my knowledge of the matter was much too superficial. But later I became fully aware of the difficulty of the task which I had undertaken. I had to make a thorough study of plant life in general, as well as of the influence of the different climatic and soil factors on the various forms of structure of the organism in every species of plant.

THE MAIN PRINCIPLES UNDERLYING THE PRODUCTION OF NEW VARIETIES

And so, step by step, for forty-seven years patiently overcoming the grievous consequences of applying erroneous methods such as Dr. Grell's notorious theory of acclimatization by means of frost-resistant stocks, which proved to be utterly fallacious, I steadily followed my chosen path until at last I came to the conclusion that *the only correct method for solving the problem is to raise new local varieties for every district from seeds. Furthermore, in order to improve their quality it is necessary to hybridize the old hardy local varieties with the best of the foreign ones.*

In the cases where there are no local varieties of a given plant, the hardy *parent* should be selected from *among the wildings that grow in countries with the most appropriate climatic conditions.* When pairing the parent plants the *most distant and least closely related varieties should be preferred,* because, if this requirement is fulfilled hybrids are obtained that most easily and completely become adapted to the external conditions of a new locality.

They give rise to the more vigorous and sturdier individuals. Whereas if closely related varieties are crossed, particularly such as have been growing near each other in a given locality and on similar soil, weak and sickly crossbreds are usually obtained that stubbornly retain the negative hereditary properties of one of the parent plants, and are therefore poorly adaptable to the conditions of a new locality. Thus the unity of the laws of creation is proved once more: just as conjugation, particularly between distant forms, is necessary for the primitive one-celled organisms, so among the multicellular plants is there a similar necessity for refreshening vitality in the progeny obtained by such means.

THE "MENTOR" METHOD

Many analogies may be likewise drawn from the phenomenon that I discovered as far back as ten years ago and have since most successfully made use of in practice, namely, that sharp changes are brought about in the

properties of an organism belonging to a new not very fertile hybrid variety during its first years of bearing if cuttings taken from a considerably older tree of a highly-fruitful variety are grafted on to the lower branches of its crown.

As a result of the influence of this operation on the genes of both varieties, during the subsequent fruiting years the following changes were observed: the fertility of the first tree—the young variety—increased tenfold, the shape of its fruit was sharply altered from round to oval-conical, their size decreased, their ripening was held up for two-three weeks, but both the taste qualities of the fruit as well as the shape of the leaf blade remained unchanged. As to the older variety grafted by cuttings, only the size of the fruit was doubled, evidently owing to the greater vitality of the younger form. Such deviation of hybrid fruiters in the desired direction, which I qualified as the application of "mentors" and the efficacy of which I more or less tested on other plant forms, is an extremely valuable tool in the hands of man by means of which he can govern the structure of plant organisms—something that was formerly not even imagined. The chance findings of the individual breeders were thought sufficient. Besides, this is a manifestation of the extremest form of mutual influence exerted by scion and stock. Although the extent of the influence is in this case due to the youth of the new variety, nevertheless such an effect, perhaps in a weaker form, at times barely noticeable, is always manifest in the usual propagation graftings of old cultivated varieties of fruit plants on to different types of stock that are practised in our nurseries. I mentioned this some thirty-four years ago in an article printed in the journal *Vestnik Sadovodstva i Ogorodnichestva* in 1888. In those days the teaching about hormones and their influence on animal organisms was just being elaborated, and now we see from what was mentioned above that almost the same phenomenon is manifest in the vegetable kingdom. Here we have the same possibility of rejuvenation, earlier sexual maturation and of the correction of various defects in structure of the organism; besides, a complete alteration of the organism as a whole may be achieved, and in the nearest future by such means man will most probably create altogether new types of plants, such as will more completely meet his requirements and be better adapted to the inevitable changes in climatic conditions.

THE INFLUENCE OF DIFFERENT CONDITIONS ON THE HYBRID

Furthermore, considerable changes may take place in young hybrids due to variation in soil composition, to atmospheric conditions during the vegetation periods of the first years of the hybrid seedling's development, to artificial non-root feeding, which will be dealt with in greater detail later on, and finally, due to forced changes in the angle of the spiral disposition of

the cells of the woody layer,[1] the so-called knottiness and many other factors that we fail to notice; besides, such changes may manifest themselves not in the organism as a whole, but in one of its parts, say, on a single branch as a so-called sport deviation.

All this quite clearly shows that not only Mendel's laws have not been sufficiently elaborated, but that the same may be said of the theory of cell chromosomes, the number of which is definite for each plant and to which the function of carrying all the genes of the parent plants is attributed. The details of both teachings will apparently require considerable revision and elucidation. Evidently, the discrepancies between the above-mentioned theories and the conclusions drawn from my observations are due to differences in the objects studied; if it is easy to calculate the percentage relationship of genes and chromosome number in pea and stinging nettle hybrids since they are annuals, it is quite difficult to do so in the case of fruit trees and perennials in general, during the development of which the influence of different factors may repeatedly change the deviation in the structure of the hybrid in the direction of either one gene or another of the parent plants and of their nearest kin; then again, the insufficient elaboration of these teachings becomes even more evident when it comes to facts which the preachers and adherents of these doctrines have not sufficiently considered, namely, when different percentage relationships of genes inherited from the parents are manifest in the different parts of one and the same hybrid individual.

Thus, for example, at the first fruiting of a Glogerovka × Reinette d'Orléans hybrid individual branches of the crown bear three types of fruit manifesting a mixture of parent characters, i. e., vegetative segregation had taken place, just as in hybrid rabbits where one foot and one ear bear the structure and the colouring of the father, while the second foot and ear completely resemble those of the mother. In human beings, too, although quite rarely, sharp manifestations of this phenomenon may be observed, as for example in eye colouring, where one eye is coloured according to the mother and the other according to the father. In each hybrid and in some crossbreds of perennial plants at the early stages of their development the majority of genes transmitted to them by their parents are in a latent state, and only gradually in the course of many years do they manifest themselves to a greater or lesser degree, depending on the positive or negative influence of the various external factors.

Such gradual form-building of the organism, as for example in fruit trees, may sometimes continue for dozens of years; during this stretch of time the changes in the shape of the leaf blade and of its stem, the length of the peduncle, the colouring and size of the fruit betray the ceaseless struggle for existence that each gene wages, with that one conquering which happens to find favourable conditions accidentally existing in the environment, or arti-

[1] This is achieved by means of a special contrivance: a ratchet-wheel divided in halves and attached to a metallic rod with rubber washers for the clamping and the twisting of the seedling.

ficially created by man; genes that have been inherited in a lesser degree, or such as fail to find the proper basis for development, are partly destroyed altogether, and partly remain in a latent state so that they may be handed down to the following generations.

THE APPEARANCES OF NEW PROPERTIES AS THE RESULT OF HYBRIDIZATION

Furthermore, the combination of certain genes and the influence of extraneous factors may sometimes give rise to absolutely new, hitherto unknown properties in the hybrid; thus, for example, the fruit of the new hybrid pear Michurin Beurré Zimnaya[1] obtained from the cross of Beurré Diel with the Ussurian wild pear if damaged at the time of harvesting do not rot during the winter storage, but the scratches or cuts dry up or even cicatrize; this is due to the fact that the pulp of the fruit is unfavourable for the development of molds or rot bacteria. This property, of course, was not only absent in the parent varieties, but in general I never met with such a characteristic in pears.[2] The hybrid trees, particularly those obtained from the crosses of distant forms, let me repeat, often produce sports during their first fruitings not only on separate branches of each tree, but it sometimes happens that the structure of one and the same shoot varies along its length. This was particularly manifest in a hybrid obtained from the cross between the Niedzwetzkyana apple and our Antonovka; as it is known, the leaves, flowers, fruit, bark and the entire wood of the first are of a red colour. When the Niedzwetzkyana apple was the female parent it transmitted to its hybrid the red pigment only on one side of the trunk, branches and shoots; this peculiarity persisted for several years, during which the hybrid's growth was extremely slow due to the irregular structure of the wood, the shoots matured only towards late autumn, and in winter the young growth would be nipped by the frost along half its length. But finally the pigment passed on to the other side of the shoots, spread evenly among the different parts of the plant and the summer growth of the latter reached its normal level; evidently the genes of the female parent (the Niedzwetzkyana apple) conquered and altogether supplanted the genes of the Antonovka[3] in the development of the hybrid.

Such an uneven distribution of parent genes is likewise found in annuals, but the results obtained are not the same (it should be borne in mind that

[1] This is a variety of a northern Duchesse, the fruit of which may be storaged throughout the winter months up to April. In northern conditions it may be twenty times as profitable as any of the former varieties of pears.

[2] Among such hybrids excellent winter apples are to be found that have a fine flavour, and that are not only seedless, but even lack a core. The fruit of this hybrid assume the shape of the nearest neighbouring variety.

[3] This strange phenomenon is well worth considering and explaining. It would probably serve to elucidate considerably the puzzle of double fertilization, discovered by S. Navashin and Guignard.

this refers only to interspecific hybrids and not to hybrids between closely related varieties).

HYBRIDS BETWEEN MUSKMELONS, PUMPKINS AND WATERMELONS

First of all, in the majority of cases simple methods of crossing either altogether fail to give any results, or the fruit obtained—as, for example, on the pumpkin plant fertilized by the pollen of an early-ripening muskmelon—continue to develop only up to the time of maturation of the melon; after that their growth is impeded and the fruit begin to decay without having ripened. Such is the case if the genes of the parents are completely mixed; if the genes are partly segregated in the different parts of the fruit, when the so-called "xenias" appear (i. e., in the first year after pollination on the fruits that develop as a result of the cross), the fruit becomes fully developed and manifests sharp deviation in structure in the direction of either one of the parents. This year a muskmelon fertilized by the pollen of a watermelon bore a fruit two sections of which had a shiny hard rind of a dark green colour, whereas the rest of it was yellow; the flavour of the pulp, unfortunately, was not altered in the least, while the seeds, although uniform in all parts of the fruit, were smaller than those of any other variety of muskmelon. Another crossing of the same kind produced an externally normal fruit, only the flavour of its pulp was very much like that of the watermelon. Both cases, being such rare phenomena, were confirmed by experts, and a water-colour drawing[1] was made of the fruit in the first case.

Next spring (in 1923) the seeds will be studied. Normally ripening pumpkins were likewise obtained when the plants were pollinated by the muskmelon, but their flavour was by no means exceptional. This is evidently due to the unsuitable pairing of the parent plants.

HYBRIDIZATION BETWEEN DIFFERENT SPECIES AND GENERA

Here I find it appropriate to state, that despite the general belief in the difficulty of crossing plants belonging to different species—and more so—to different genera, I have lately obtained quite a number of interspecific hybrids and a few cases, although rather doubtful ones, of intergeneric hybrids. The latter may have been obtained without the fusion of the parent gametes but as the result of the direct influence of the fecundating source (the pollen) on parts of the maternal plant other than the egg cell, thus calling forth the parthenogenetic development of the latter. As to the degree in which the genes of the parents are transmitted to the hybrids, my observations have led me to believe that not only does the individual vigour of each plant type play an important role, but also that the age of each plant and the age

[1] This drawing was not found in the Michurin archives.—*Ed.*

of the species as a whole are of significance. Thus, the greater the stretch of time that a given species has been existing in its place of origin under similar soil and climatic conditions, the greater will the degree of hereditary transmission be which the individual plants belonging to this species possess. Furthermore, the older the plant chosen as a progenitor, the greater is the force with which it transmits its genes to the offspring, and conversely, if the plant is young, in its first years of bearing, and particularly if it is a hybrid of recent origin, its hereditary power reaches a minimum. Even artificial weakening such as preliminary transplantation or excessive drying of one of the parent plants lead to the reduction of this power.

THE TECHNIQUE OF CROSSING

When choosing the flowers for the crossing on the branches of the tree's crown those situated nearer to the stem and to the base of the branches should be preferred, since there is a greater influx of sap to these parts, providing better conditions for the developing fruit. Besides, fruits so placed are better protected from wind and hail.

My methods of effecting simple crosses between varieties belonging to one species are in no way remarkable. At first the flowers of the maternal plant are carefully castrated, then the pollen of the male parent that had been gathered in a glass jar the day before is placed on the stigma of the pistil of the castrated flower, this operation being repeated for three consecutive days, and in rainy weather—longer. Furthermore, a flower so fertilized is covered by a white bag made of cheesecloth or tulle, sometimes soaked in celloidin dissolved in vinegar ether to keep it round. This is particularly beneficial in rainy weather, since it prevents the washing off of the pollen and preserves the spherical form of the bag. Then, of course, a tag is attached bearing the number and the names of the parent plants.

THE TECHNIQUE OF CROSSING INDIVIDUAL PLANTS

In hybridization when crossing plants belonging to different species, particularly if they are distant ones, I have been using a completely original method that has never been used by anyone else. This method gives much better results than the simple methods of crossing formerly used which in the majority of cases proved to be utter failures. My original method has been elaborated on the basis of the considerable changes that the properties of a small part of a young plant (a cutting) undergo when grafted onto the crown of a different variety. These changes take place under the action that the entire root and leaf system of the latter exerts upon a very small part of a young plant that is as yet rather unstable in respect to various changes. (By this method vegetative hybrids are most easily obtained, if the grafted cutting is kept under such influence for three-five years and is then transferred on to a separate young stock.)

I use this vegetative change as an auxiliary means of approximating two different plant species so as to obtain a sexual hybrid by crossing them in the future.

THE RESULTS OF CROSSING VARIOUS SPECIES AND GENERA

This is the secret of my success in obtaining interspecific plant hybrids, such as crosses between the apricot and the plum, sweet and sour cherry, *Pyrus salicifolia* and the local cultivated pear varieties; between the various species of walnut, the various species of grapes, the various species of quince; between the pear and the mountain ash; between distant species of apple; between species of currant and other small-fruit shrubs; between pumpkins and muskmelon, musk and watermelon; between the various species of lilies; between Physalis and tomatoes, etc.

Therefore, in the cases where simple crossing between different species of plants failed to give good results, the introduction of preliminary preparation by means of vegetative approximation helped me to produce more than a hundred new varieties of plants. Besides, a number of plants hitherto unknown in our region have been introduced into culture. Half of these new fruit and berry cultures will be suitable for the northern districts of Russia and for Siberia, whereas the second half may serve to increase the number of selected excellent varieties in the assortment of fruit culture extant in the districts of the central part of European Russia. Thus, there is still the possibility of considerably pushing northward certain varieties and species of plants, since these new varieties when raised from seed in our region and grown under the constant influence of its climatic and soil conditions have proved to be quite stable in our parts.

THE DETAILS OF THE METHODS OF CROSSING INDIVIDUAL FORMS

To make things clear I shall dwell in greater detail on the working of my method. When a simple cross between plants belonging to different species fails to take place, preliminary vegetative approximation is effected. This is done by taking cuttings from a young one- or two-year-old seedling belonging to a certain species, preferably a crossbred (that is, a plant that is a hybrid itself) and not a pure species type; several cuttings are always taken, since not every individual possesses the ability of coalescing with plants of another species. In the spring these cuttings are grafted by means of a Geissfuss on to several branches of a mature (about ten-year-old) tree belonging to a different species—a parent plant in the future. Here the grafts develop and are gradually altered in structure under the influence of the entire root and leaf system of the tree up to the first simultaneous blossoming of both species; this is the time when a more or less successful crossing is effected. There is no need to be discouraged if the cross fails to take place

at the first blossoming or if the seeds obtained from the cross fail to germinate, since after the second bearing on the following year these defects almost always disappear, with very rare exceptions.

The same method, only taking into account the short cycle of development, may be applied to annual vegetables; cuttings taken from the end shoots of one species are first grafted into slanting notches on the runner or shoot of a more vigorous plant of another species, for example, a muskmelon or watermelon grafted on to a pumpkin, Physalis on a tomato, a tomato on a potato, etc. (but not the reverse), and after that a sexual cross between the two species is effected.

GROWING HYBRID SEEDLINGS FROM SEEDS

As to my method of raising from seeds and training seedlings of crossbreds and hybrids of fruit plants with the aim of producing new and better varieties, I can give the following brief instructions.

1. First of all, when choosing the parent plants those that have their own root system should be preferred, or such as were obtained by layering or grown from cuttings, since the root system of the stock influences seed formation, making the seeds deviate in the direction of the latter. Plants grafted to wildings may be taken only if no others are available.

2. The seeds gathered from the fruit of the cross should not be overdried, if possible. Time and again experience has convinced me that the best qualities of the seedlings are considerably reduced if the seeds are overdried. That is why I plant the seeds not later than three-five days after extracting them from the ripe fruit, even though it may be winter.

In the latter case the seeds are planted in beds with furrows running through them that have been prepared in an open space in the orchard in the fall and are covered with thawed earth; or they may be planted in boxes three vershoks high filled with light earth that have been likewise made ready in the fall. After the planting the boxes are placed under the snow in the orchard.

3. In the spring the young growth of the seed cultures, at the time when two or three leaves appear above the cotyledons, is pricked out to beds with a well-turned soil at four-vershok distances between the plants, each plant being slightly shaded during the first three days.

Stone cultures should be planted more thinly and pricking out should not be practised since it has a harmful effect on them. Better to transplant them in the spring.

4. During the first and second year of the seedling's growth, in exceptional cases—when it is desirable to improve the development of a seedling—non-root feeding may be practised; for example, a fourteen per cent sugar solution may be injected into the plant. This is accomplished by means of a large medical injection needle used for subcutaneous injections to which a so-called thin rubber drain about three vershoks long is attached, the loose end of the latter is fitted into a cork stopper of a small bottle without a bottom which is held upside down at a level of about six vershoks from the

ground. The needle is inserted into a horizontal cut that had been previously made on the bark, and is then turned so that its hole lies tangent to the circumference of the wood, and at the same time slightly raised, so that under the bark a small empty space appears where the sugar solution under the pressure from above is gradually absorbed by the cambium and thus adds to the nourishment of the plant. However, this method cannot be practised in the case of stone cultures.

5. So as to avoid training superfluous numbers of seedlings in the fall of the second year the best specimens are selected in respect to appearance and frost resistance as judged by their first wintering. It is absolutely impossible to iterate the characters on which the selection is based, and yet the success of the enterprise mainly depends upon this. It is impossible to give a definite description of the characters because they vary in one and the same plant, or better say in one and the same individual under the influence of the different changes, at times quite insignificant ones, that take place in the environment. Only experience gained by many years of labour makes things clear. The seedlings should be selected in the autumn because it is essential to see the entire leaf system in its complete development, transplanting should be done only in the spring and the seedlings should be kept in the same beds covered with twigs of evergreen as a protection from mice.

The seedlings are transplanted into fresh soil that has not been exhausted by the growth of similar cultures and spaced at a distance of one arshin between the plants in a row, and two-three arshins between rows; all the extra branches are pruned, leaving only the continuation of the main stem and three or four branches so as to concentrate the influx of sap at a small number of growth points. During the vegetation period the usual clearing, weeding, hoeing and watering of the soil around the plants should be practised, and liquid fertilizers should be applied if necessary.

6. Such is the regime of the seedlings up to their first fruiting at the age of five-ten years. According to the properties of each individual the first fruit are either excellent from the very beginning, or they manifest only the rudiments of their good qualities; their complete manifestation is gradually attained, sometimes after a period of many years during which time the fruit changes in form from a wild forest sourling to a well-sized first-rate cultivated variety with an excellent flavour. This evolutionary change should be accompanied by careful tendance, and by a constant correction of any defects in nutrition, moisture and other requirements. Neglect of this point is the principal reason for the formerly current erroneous belief that from the seeds of cultivated varieties of fruit plants only wild forms are obtained.

7. During the first years the bearing of the hybrid tree should be limited by a minimum number of setting fruit so as not to exhaust the young and as yet unstabilized organism. Only the number of fruit that is absolutely necessary for the appraising of their quality should be left on the tree. Besides, care should be taken to prevent the pollination of the flowers by wild species which may lead to regressive deviations in the structure of the fruit.

8. At this particularly important period in the life of the new variety, when it enters into the first stage of maturity, if the good qualities of its fruit were not sufficiently developed or if it manifested certain undesirable genes of one of its parents, I often was able to correct these defects by "supplying a mentor," as I called my method. This is accomplished by grafting on to the lower branches of the tree nearer to the trunk a few cuttings taken from an old tree of an old cultivated variety, particularly one highly endowed with a quality lacking in the new variety.

In most cases this method gave excellent results in correcting defects, but sometimes it proved to be an utter failure, which was evidently due to the choice of an unappropriate mentor or to the weakness of its influence.

9. When on a hybrid tree several different so-called sport deviations in the quality of the fruit appear, the branches bearing fruit of the best quality should be preserved and the rest should be pruned, or still better, cuttings from the first branches should be grafted on to the latter.

When it is desirable to preserve several varieties it becomes necessary to graft them on to different and very young (two- or three-year-old) stock grown from the seeds of any cultivated variety. In these cases the seedlings of an old well-known variety, Skrizhapel, proved to be the ideal stock, which always improves the fruit qualities of the grafted variety in every respect.

10. A large number of the sexual or vegetative hybrids and crossbreds of the new varieties produced, with the exception of those that have ceased to change already before their first bearing, should be strictly kept in the nurseries, and should not be propagated by means of the usual grafting in the nursery garden until their development is completed, the quality of their fruit manifest, and the structure of the organism as a whole stabilized. Otherwise various deviations in the properties of the new variety may occur due to the vegetative influence of the stocks on the specimens inopportunely propagated by means of grafting. The period during which the plant is kept in the nursery lasts from two to five years after the first bearing, depending upon the individual properties of each plant, and only in exceptional cases does it stretch over several dozens of years. Thus, for example, my new variety of apple, which I named Kandil-Kitaika and which was obtained from the cross of the Crimean Kandil Sinap with our local *Pyrus prunifolia* in its first year of fruit bearing (1902) produced fruit the size of an ordinary Kitaika and then in the 18 years following the fruit gradually increased in size and improved in taste until they finally surpassed the Crimean Kandil in both size and flavour.

In conclusion I should like to note that in general, and in this brief resumé of my work in particular, I make no pretentions to having demonstrated new discoveries or having refuted any laws established by authorities in science. I am only giving an account of my conclusions and arguments based on my personal experience of many years of work on producing new varieties of fruit plants. It is very probable that in some cases I may be wrong due to having erroneously interpreted various phenomena in the life of plants and the application of, let us say, the laws of Mendel or other

modern teachings to them; but such mistakes are inevitable in every work and they cannot be of much significance since they will in all probability be rectified by other investigators in the future.

First published in 1925 in
I. V. Michurin, *Results of Forty-Seven Years of Work on Hybridization in the Field of Horticulture*

TO MY COLLABORATORS[1]

Now, on the basis of the reasons mentioned above, it is *required* of everyone who wishes to succeed in the work of breeding new improved varieties of fruits to be thoroughly acquainted with the following:

1) In order to be able expediently to select pairs of parent plants, it is necessary to acquire as extensive information as possible both about the wild species of fruit plants in the two temperate belts of the globe and about their cultivated forms or, at least, about the latter's nearest of kin.

2) It is necessary to know, approximately at least, the degree of the potency of hereditary transmission of genes to their progeny by the species and varieties of the plants employed as parents at their different ages and under different influences of climatic and soil conditions.

3) One must learn to maintain and perpetuate the development in hybrids of desirable characters and, vice versa, to check or reduce manifestation in the hybrid of genes with negative properties. Learn to find more effective methods in this respect. For example: influence exercised by the stock, the mentor method, vegetative approximation.

4) It is necessary to learn to find, recognize and then eliminate, or, where this is impossible, at least lessen, all harmful influences of extraneous factors.

5) In training seedlings of hybrids which have been renovated through conjugation by crossing with species and varieties obtained in places remote from their native land, it is necessary to avoid excesses in supplying them with food and moisture, in deep loosening of the soil, protection from frosts and similar auxiliary measures so generously introduced by modern culture, which profoundly disturb the self-activity of all parts of the plant organism to the point of complete atrophy of their vigour in the struggle for existence. Modern conditions of life require robust fighters; frail fondlings are inexorably doomed to perish....

6) The process of hereditary transmission of genes from parent plants to hybrids does not in itself—and also in view of the influence of extraneous factors which are vast in their complexity—follow, nor can it, in fact, follow, any previously defined patterns elaborated by theoretical science; and this applies *in equal measure* also to the choosing of hybrid seedlings on the

[1] These are evidently the conclusive remarks of Michurin's instructions to his immediate pupils written in 1925. The beginning of this paper has not been found in the Michurin archives.—*Ed.*

basis of the characters of their habit, when often a seedling, which, on account of the large size of its foliage, the thickness of shoots and the frequency of internodes, is regarded by the layman as the best specimen, turns out in the end to be a wilding, with poor small fruits, and, on the other hand, another seedling, one that has been discarded, but which has among its external characters only some one good character unnoticeable to the inexperienced eye, may yield excellent fruit. In view of all this, one can rely, in choosing seedlings, only on one's own practical experience, whereby one acquires in the course of time the skill of correctly assessing the merits of seedlings by their external appearance, their habit. Furthermore, besides such selection twice or thrice repeated, selection must also be made for the immunity of the plants to various diseases and for their resistance to the attack of various pests and parasitic fungi, both such as cause the inside of the fruit to rot and such as infest the surface of fruits and leaves with rust. I repeat that correctness of all such selections can be attained only by long practical experience, and that all attempts at observations and deductions on the basis of scientific discipline, to use the expression of the various diploma-holders, can so far perhaps be applied only to annual cereal plants, but certainly not to perennial fruit and small-fruit plants. All ostensibly learned opinions on this subject I regard as the empty phrasemongering of people who do not know what they are talking about.

7) A new variety may be allowed to be propagated only after it has borne fruit for several years and after the mother plant has developed full stability and unalterability of qualities.

8) Concerning the apprehension I have heard expressed by some persons to the effect that hybrid varieties degenerate in the course of time: such degeneration only occurs in annual garden and field plants which are propagated by seeds; however, perennial orchard plants, both trees and berry shrubs, are propagated vegetatively by grafting and cuttings, and therefore there can be no degeneration in their case, except when the propagation of a young hybrid variety by grafting has been begun too early, not at the proper time.

9) It is necessary to know that no cuttings must be taken from still young hybrid seedlings for propagation by grafting, particularly on the crowns of adult trees, even if of cultivated varieties, because in the majority of such cases the grafted hybrid is apt to deviate towards wildness. Note that the form of the leaf blade of such a graft remains unchanged at the point of heterogenesis at which it was when the cutting was severed, and in some cases we even observe a pronounced deviation towards the wild species, something which anyone can easily notice by comparing the shoot of the graft with the seedling from which the cutting for the grafting was taken. Propagation may be started only when the hybrid seedling has begun to bear fruit, and even then not in the first year but after three or five years of fruit bearing (!).

1925

SYNOPSIS[1]

From the experiment in uniting apples and pears with the lemon and bitter orange, and, particularly, from the experiment in joining the sour cherry with the apple, in which the branches and leaves are left on the stock, it should be clear to us that:

1) For the complete symbiosis of species which are far apart from each other, a certain period of time is required, different in length for each combination of union, in the course of which the roots, while only gradually yielding to the influence of the scion, partially alter their activity.

2) The scion, even if it is very small in comparison with the stock, exerts strong influence on the plant which serves as the stock; for example, the branches of a pear stock on which a lemon cutting was grafted ceased, under the influence of the scion, to shed their leaves for the winter, and the leaf blades underwent a structural change as regards their colouring and also as regards their thickness and gloss. This proves the "mentor action."

3) It has been noticed that in some cases, when the aerial portions of the stock have all been removed and its leaf system is absent, the scion of the different species and the work of its leaf system provide, in the majority of cases, insufficient building material for the development of the roots. Here is an example: A pear of the old Bessemyanka variety, grafted on an apple stock, at the age of twenty-five years had a stem 18 cm. in diameter, whereas the root neck below the point of grafting was only 7 cm. thick, owing to which the tree with its broad crown had to be supported by four posts. This was particularly necessary because of the greatly enhanced annual fertility of this tree. Such a phenomenon, though in a lesser degree, may often be observed in cases of grafts made high up on the stem and in cases of pears worked on pear stocks, and apples on apple stocks, of the same species.

Apparently, even in such cases the difference in the constitutions of the stock and the scion is so great that it approximates the difference between stocks and scions of different genera, and the stem below the point of the graft is much thinner than above it.

4) Of course, in the combinations of artificially induced symbiosis of plants, mentioned above, we do not find such luxuriant development of the plants as is usually observed when plants of the same species are joined; but this does not at all prove that we cannot under these conditions achieve much better results. Everything here depends on the length of time required for the young hybrid plants to adapt themselves to the conditions of the given symbiosis. And the length of the period during which the constitutions both of the stock and of the scion will fully accord as the result of the interaction of the leaf systems depends on the individual properties of each separate specimen in the given combination of plant pairs. It follows from all this that in the future we must not expect plants which participated in one

[1] Notes from I. V. Michurin's diary.—*Ed.*

combination of pairs to be suitable for another combination. Each plant in a union adapts itself only to its own pair, and not to the whole species.

5) In the animal kingdom, too, and also among human beings, pairs become habituated, mutually changing each other; for example, husband and wife who have lived together for a long time begin strongly to resemble each other; even their characters draw closer to each other, becoming something half-way between what they were before.

6) In conclusion I must say that the experiments in symbiosis were, of course, made not with the aim of breeding lemons or bitter oranges on pear stocks, or sour cherries on apple stocks, as that would have been absurd, to say the least. The experiments were made with the aim a) of graphically clarifying what influence is exerted by the stock on the scion, b) of proving that the property of adaptation of hybrid plants is most potent at their earliest possible age, and c) of obtaining by means of layers and cuttings a fixed alteration in the constitution of the strain as the result of the influence exerted on it by a stock of a different species.

1926

A CRITICAL SURVEY OF RECENT ACHIEVEMENTS IN GENETICS

At last I have the long-awaited opportunity to compare and check various conclusions drawn from the results of my work in one department of genetics with the thirty-five years' practical work of an eminent American scientist—Professor Hansen—as reviewed in his paper at the Fifth International Congress of Genetics, held in 1927 in Berlin.

First of all I wish, on the basis of my fifty-four years' work in breeding new fruit varieties with a view to improving assortments in the central and northern areas of the U.S.S.R., to state my views on the provisional, as Hansen calls it, hypothesis which he takes as a basis—namely, that wild homogeneous species should be used in plant improvement instead of cultivated varieties, because of the heterogeneity of the latter (p. 6). Regarded from the scientific angle, all this is of course valid, and in the early years of my work, I too was carried away by the idea of securing in this manner fully constant varieties which could be propagated by seed without changing their properties. But this proved so difficult of achievement that the practical requirements and conditions of life made it quite impossible to follow this line, if only because it would have taken too long to obtain satisfactory results. If, as Hansen tells us in the case of annuals like rice or maize, five to ten generations had to be reared, that is, about ten years were required, then in the case of fruit trees, with life cycles lasting several decades, it would take at least several centuries to bring *Pyrus Malus* to a completely stable homozygous condition; it would be too onerous an undertaking; and then an equal if not greater period of time would be needed to obtain varieties of better quality than we have at present; moreover, consumers will be making quite differ-

ent demands at that date, they will scarcely be satisfied with Hansen's "sauces." As against this, by the simple expedient of amalgamating existing cultivated varieties, even if they are heterozygous, thousands of new varieties will result during this time, out of which hundreds can be selected both for homozygosity and for superior taste and appearance. As to attaining the ideal in this respect, anyone can see that humanity will not be able to attain it. A gross error was and is committed by those who found their opinions on the fact that, among wild fruit trees, individuals with large and palatable fruits have been discovered, such as the pear Forest Beauty (Fondante de bois) or large-fruited apple trees—maintaining that such trees belong to pure species, whereas they in all likelihood sprang from seeds carried there accidentally from cultivated orchards in bird droppings or even human excrement.

Nature does not ordinarily make such sudden leaps (*Natura non facit saltus*), otherwise in the course of these thousands of years all pure species of fruit trees would have evolved a considerably greater diversity of forms than we see at the present time. It is only because some seeds chanced to find themselves in particularly favourable soil conditions, and because the resulting individuals were found by man and have been tended by him for several thousand years, that we have our best present-day cultivated varieties and that there has been such an improvement in their quality. To ignore these and start the work all over again from wild species would be an utterly irrational labour of Sisyphus.

Still, bearing in mind the considerable scientific value of the line indicated by Hansen, it should be adopted for guidance with a view to attaining an easier mode of development of horticulture in the future. I for my part would suggest that work on Hansen's method, which requires a very great period of time for its complete realization, should be conducted not at experimental stations, where the entire personnel changes frequently, but exclusively by the teaching staff of specialized agricultural colleges. As to the breeding of improved fruit varieties at ordinary experimental stations, there it is best to do it by crossing good cultivated types, selected both for their relative homozygosity and for superior qualities in other respects. Among such types, special attention should be given to the relatively more homozygous, as, for example, to Golden Pearmain, that oldest of fine varieties. This type has become stabilized, evidently through having been in existence for a comparatively long time, and even among its hybrid seedlings, considerable numbers are of uniform cultivated appearance. The same is true of our Crimean Kandil Sinap and Sary Sinap, which produce seedlings of remarkably uniform appearance, most of them deviating in form towards the Sinap. Other varieties that are good in this respect are Chelebi Alma and some of the Circassian types from the Caucasus. Of our local varieties, all the Anises, Bely Naliv, Borovinka, Skrizhapel, Bellefleur-Kitaika and others. Of the pears, Sapezhanka and many of the Bergamottes. Of the cherries, Roditeleva Vladimirskaya, Michurin Plodorodnaya, Griotte Grushevidny, *Prunus Besseyi*, the Samara *Prunus Chamaecerasus* and the bitter-sweet cherry. Of the plums, all the Reine Claudes and Damsons. Of the apricots, the small Mongol. Of the

peaches, Mao-Tkha-Or. It does happen that among hybrid and other heterozygous varieties there occur, as rare exceptions, types immune to disease and resistant to pests; but I repeat, this happens very seldom; all the same, of course, such varieties must be carefully preserved in the course of selection, in order to serve as parents in further crossing work, although these properties are rarely transmitted to the progeny.

Regarding Hansen's remark (p. 8) about the considerable sterility of varieties produced by crossing our cultivated types—the same fault is to be found, possibly in even greater degree, in all hybrids of pure species; each pure species is fertile only as long as it is not crossed with another, even though equally pure.

Then, as regards immunity to disease, and particularly as regards pest resistance, it has to be said that while wild-growing pure species do possess these in considerably greater measure, these properties too are preserved only up to the moment that their progeny emerges from the wild state into cultivation.

In conclusion, I would say that one should not be too much obsessed with introducing wild-growing pure species into the work. Although eventually we shall indeed achieve better results by this lengthy method, we simply cannot wait, we must secure more profitable new varieties at an early date, otherwise we are bound to fall terribly behind the all-round agricultural progress of our country, now undergoing regeneration in every respect; because all the virtues of wild-growing pure species—their constancy, fertility, remarkable hardiness, immunity to disease and to fungous parasites, resistance to pests of various kinds, and their other desirable qualities—are retained only as long as the species remain pure; whereas if the size and taste of their fruits are improved—which can only be done by extra nourishment, by inducing adiposity and by crossing them with cultivated varieties—all these properties inevitably dwindle or disappear altogether in most of their progeny. Sterility sets in; hardiness diminishes; with the development of luxuriant growth, they become capricious as to soil and tendance; and if these are deficient, or if the plants are subjected to climatic rigours, their general resistance is lowered, affording favourable conditions for mass attacks of parasitic pests. Besides, the delicacy of the nurtured foliage of the cultivated varieties naturally attracts insect pests much more than do the coarse leaves of wild forest fruit trees. This is an inevitable consequence of improving them. You will note that sometimes when young hybrid seedlings are being selected, it is regarded as a certain indication of superior taste in a seedling's future fruits if its foliage is attacked, more than that of others, by the aphids, which are spread by ants; the latter make no mistake about what is the best pasturage for the aphids.

Such is the inevitable way in which improved cultivated fruit varieties must make their appearance.

All I have said is not a bald assertion; I am merely drawing the logical conclusions that emerge incontestably from a close study of what happens in Nature.

Now let me examine individual points in Professor Hansen's communication.

1) He says that in working with heterozygous cultivated varieties of *Pyrus Malus,* which have been formed from six different pure species in the course of three or four thousand years, it is impossible to formulate definite rules for this work, and that all the results achieved in it are merely luck in a game of chance. In this one has for the present to agree with him. I, too, in the early years of my work in crossing cultivated fruit varieties, had occasion to observe the total absence of any regularity in the results obtained from hybridization. From the same combinations of parent plants for crossing, different results are obtained not only in different years, but even in one and the same summer. Seeds of one and the same fruit produce seedlings of dissimilar appearance and of different types,[1] consequently, the Mendelian law cannot be applied when crossing heterozygous cultivated fruit varieties, and it is in general practically impossible to obtain strictly predetermined results. Whole volumes of detailed notes on the results obtained from different combinations of parent plants; numerous photographs and sketches from nature; countless tables of the measurements of ovaries and of the shapes and sizes of leaf blades; microphotographs of growing pollen; records of temperature fluctuations—the whole of this Sisyphean labour is repeated inevitably at the outset by every at all serious newcomer to this work, and repeated persistently until he comes to see the utter futility of this immense but virtually useless undertaking, as there is no regularity in these phenomena by which one could be guided in one's future work. Time is wasted in vain, and so is all this mass of effort, all these notes and sketches; the only net result is practice in the details of the work. But this practice is bought too dear, at the cost of decades of labour wasted. Sometimes in working with cultivated fruit varieties, one actually encounters such paradoxes as that hybrids bred from splendidly frost-resistant parent varieties turn out to lack such resistance, and seedlings of tender varieties, on the contrary, survive hard frosts very well. So I should like to warn young hybridizers not to cherish undue hopes as to the usefulness of making such notes, tables and sketches.

All this every originator experiences in his own practical work; as to the expectations that can be placed in various theoretical data on the subject—of the experiments, drawings, tables and extracts from other people's writings that have been collected here and there by all manner of compilers inexperienced in practical work, a large proportion do not in the end produce any results of practical value. For example, we see published whole volumes on the interspecific grafting of various plants, photographs of different cross sections of grafts, microphotographs of pollen and its growth, drawings of fruits and leaves, and so on, but actually there is hardly anything of use that can be got out of all this.

[1] Pollen which grew well under the microscope proved, when it came to the point, to be of low fertilizing value, while pollen that had not grown so well yielded a higher percentage of fertilization. This sort of thing has also been observed in America and in our Ukrainian Republic by Ro.

A lot of talk, and little real work. Take for example the description of grafting tomatoes upon nightshade; well, what was the result obtained by it? Were seeds planted from such grafts? Did a new improved plant result? We are not told any of this.... And it is the same every time. The white lily produced seeds. Well, did the seedlings from these seeds yield a plant capable of producing seeds in its turn?

There you have a picture of how difficult it is to work with heterozygous varieties; but nonetheless I repeat that, economically if not scientifically, this method of working with cultivated varieties of perennial fruit plants is the more profitable, the one that produces quicker and better results.

This is the method to be preferred in our nurseries; only in this way shall we avoid falling behind the general rapid progress of our agriculture.

As to crossing wild-growing pure species with cultivated varieties, in the overwhelming majority of the resultant hybrids it is the inherited characters of the wild species, as the more energetic in transmitting its characters, that prove to be dominant; particularly is this the case if it is also fostered by a comparatively severe climate in the locality where the seedlings are reared, or even by the influence of a chance cold summer. The fruits of the resultant varieties are too small in size and inferior in taste, they cannot be marketed. Only in rare cases are they of a tolerable flavour, and then only if the role of pure species was filled by one of questionable purity, such as our orchard-grown Kitaika apple—by a species, in a word, which has for several generations been propagated by seed taken from trees that have long grown in our orchards among cultivated varieties, and which, consequently, has long lost its specific purity under the influence of cross-pollination and cultivation. This is strongly perceptible even in the case of so stable a species as the small Siberian crab, if the seedlings have been produced from seeds of trees growing in our orchards and not in the forests of this species' native Siberia. The same has to be said about our local wild pears, about various damsons, and to some extent about the steppe cherries too.

Then, as regards the so-called segregation of characters into parent types, which I have never seen in reality—in second-generation seedlings you always get totally new combinations of characters, often of absolutely new properties which the parent plants never possessed; and what is more, under the influence of our relatively severe climatic conditions, the majority of second-generation seedlings always deviate in the direction of worse properties. And so, against the established opinion of many experts that it is useful to work on rearing second-generation hybrid seedlings of perennial fruiters, I rear hybrid seedlings of the first generation only.

Page 5—Hansen says that many excellent seedlings have been obtained from poor parent plants and, vice versa, poor seedlings from good parents.

This can be accepted in part only in regard to the crossing of heterozygous cultivated varieties, since one may get hybrids with characters inherited not from their immediate parents, but from distant ancestors unknown to the originator.

When, on the other hand, it is homozygous wild-growing pure species

that are combined, such paradoxes can of course never occur. However many times you may cross the small Siberian crab with any of the American wild crabs, you will never, of course, get any large-fruited, palatable variety, unless you first improve these wild types by cultivation.

Page 31—hybridization with *Pyrus Malus* always introduces insufficient hardiness for northern localities. That is true. The reason is, first of all, that the warm summer time in northern localities is too short for the new growth to finish developing and the wood to mature completely; and also that the plants have been pampered by cultivation and are accustomed to more favourable climatic conditions, from which plants lose their hardiness—even such Siberian plants as *Hippophaë rhamnoides*, seedlings of which raised from seeds received from Germany are killed by frost in our parts the very first winter, whereas Siberian seeds produce completely hardy seedlings.

Every organ, every property, every limb, all the internal and external parts of every organism are conditioned by its environment. If the plant is organized as it is, that is because every detail in it performs a certain function, possible and necessary only under the given conditions. Should these conditions change, the function will become impossible or unnecessary, and the organ performing it will gradually atrophy. Take as an example the wild apricot *Prunus armeniaca var. sibirica,* which grows on the mountain slopes near the town of Nerchinsk in Eastern Siberia and there endures temperatures as low as −55°C. Yet here in Central Russia its seedlings perish one and all of the cold. The reason is the longer summer in our parts compared with the similar, but short summer in Nerchinsk. Over here, the seedlings start growing again at the end of the summer. The wood of the new growth does not have time to mature before the frost sets in and kills it.

1929

PRINCIPLES AND METHODS

AUTHOR'S PREFACE TO THE FIRST EDITION

THE SUBJECT-MATTER OF THE PRESENT EDITION

Feci, quod potui, faciant meliora potentes![1]

In setting about to give an account of the results of my fifty years' work devoted to the horticulture of the central zone of the European part of the R.S.F.S.R., I am unfortunately compelled at present to restrict myself to publishing only the first volume. That would include only about one-quarter of what I have to write about all of my achievements.

Only a part of the new varieties of apple and pear that I have originated is described here. The description of other new varieties of apple and pear, of plum, cherry, apricot, quince, grape, walnut, rose and various

[1] I have done all I could, let those do better, who can!

small-fruit shrubs, as well as the description of many experiments and also of my methods of work has been put aside until the subsequent volumes are published.

Moreover, some recent works of mine, such as the introduction of peaches and almonds into culture in the central zone of the European part of the R.S.F.S.R. require some additional control experiments before the ultimate reliable results can be ascertained. Namely, it is necessary to make some intercrosses of the forms already introduced by me as intermediate links between the cultivated varieties of peaches and the sole representative of the *Amygdalus* genus in our local steppe flora—*Amygdalus nana L.*

Besides, included in the subsequent volumes will be descriptions of various interspecific hybrids obtained from the crosses of plum × apricot, sour cherry × sweet cherry, sour cherry × bird cherry, mountain ash × pear, hybrids of *Juglans regia L.*, *J. nigra L.*, *Hicoria Pecan Brit.*, etc. There will also be accounts of experiments on the introduction into culture of some fruit and small-fruit plants that had hitherto never been grown in our zone, such as *Actinidia Lindl.*, *Schizandra Mchx.*, the mulberry (*Morus L.*), *Shepherdia Nutt.*, the sweet chestnut (*Castanea vesca Gaertn.*), *Corylus mandshurica Maxim.*, *Prunus tomentosa Thbg.*, *Prunus serotina Ehrh.*, the wild peach (*Amygdalus pedunculata, Am. pilosa, Prunus plagiosperma Oliv.*), the persimmon (*Diospyros lotus L.*).

The material is to be distributed among the volumes as follows:

Volume II will contain the descriptions of new varieties of apple, pear, cherry, and plum, as well as the recently originated varieties of apricot, almond, quince, mountain ash, peach, plum and cherry. The fruit of these varieties will be shown in figures and plates. Descriptions of the most recent observations and experiments will be also given in this volume.

Volume III will include the descriptions of new varieties of small-fruit shrubs, such as the grape, gooseberry, currant, raspberry, blackberry, actinidia, sea buckthorn, shepherdia, barberry, *Schizandra chinensis* and some others.

Various species of strawberries, certain vegetables and flower plants are left for the fourth volume.

AUTHOR'S PREFACE TO THE THIRD EDITION

For dialectics "... nothing is final, absolute, sacred. It reveals the transitory character of everything and in everything; nothing can endure before it except the uninterrupted process of becoming and of passing away, of endless ascendancy from the lower to the higher." (F. Engels)

This principle has always been and remains the basic principle of all my work. It has been emphasized in all of my numerous experiments on the improvement of existing varieties and on the origination of new varieties of fruit and berry plants.

Of particular significance are the changes that have taken place in our country during the years that have elapsed since the Revolution.

The socialist system has brought the working people in our country to confront new historical tasks in full accordance with their vital and intellectual requirements.

By the unsurpassed efforts of the working class guided by the Bolshevik Party, Russia, hitherto a backward, stagnant country, has been successfully converted into an industrial state, which is being built on the basis of a complete technical re-equipment of the entire national economy. The task of developing the productive forces of the Soviet Union is being solved in a new way on the principle of expedient planning which reveals the fabulous economic opportunities, that for the most part still have not been made use of.

Where the private proprietors formerly plundered there now works in full harmony a unanimous and powerful society armed with a much better technical equipment and with scientific knowledge.

Relations between the town and the village have accordingly undergone great changes. The problem of production and consumption has now acquired an entirely new aspect; new economics, new customs and new laws have come into existence. It is natural, therefore, that both industry and agriculture have to meet absolutely new requirements of the working people, so that any lag, any discrepancy or lack of agreement in the work with the general socialist principles of economic management will do great harm and will hinder the construction of the new socialist national economy. The same holds true with respect to our field of work, that is, to the work of producing new varieties of fruit and small-fruit plants, which is an integral part and one of the most important branches of socialist agriculture.

Only when the problem of producing new fruit and berry plants will be tackled by the experimental stations scattered all over the U.S.S.R.—stations that are affiliated with the Scientific Research Institute of Fruit Growing named after me; only when these stations will carry their work of producing and testing new varieties of plants directly to the point of production of each district and will manage to attract the attention of sovkhoz and kolkhoz workers to this task, only then will the requirements of agrotechny and selection be more fully taken into account and selection will to a greater extent be able to meet the demands of agrotechny. Only on such terms can selection become a mighty weapon in the fight against the drought, in the struggle for high and steady yields from cultures grown in socialist fields and orchards.

To be brief, the fruit grower in his work must always serve the interests constituting the essence of our economic and social system; he must be fully aware of the methods he employs and of the ultimate purpose of his work.

The urgent tasks of the present day set before the workers of socialist agriculture are absolutely definite. The Seventeenth Congress of the Communist Party of the U.S.S.R. outlined the course of development of agriculture, expressed by Stalin in the following words:

"... every region will have to develop its own agricultural base, so as to have its own supply of vegetables, potatoes, butter and milk...."

That means that the urgent task set before fruit growers is the extension of the fruit-growing area to the north and east.

Publishing this third revised edition comprising two volumes of my works, I want to draw the attention of fruit growers to the necessity of making as much use of my experience as possible in their work, giving it a proper direction to meet the requirements of today.

As regards the production of new varieties of fruit and small-fruit plants, the breeders are confronted with the following tasks:

1) The determination of the regional distribution of varieties and a thorough study of the varieties that I produced as regards their behaviour in the different regions of the central and northern zones of the U.S.S.R. varying however little in soil and climatic conditions; propagation of these varieties should be based on the results of this study and should be carried out on a scale that would meet the requirements of the developing socialist horticulture.

2) The correct choice of stocks which are of decisive importance as a base for the fruit trees. Making use of the results of my experiments where they have proved to be perfectly reliable or where they may offer a foothold, no matter how small, for the further ascent to more perfect methods.

3) The production of new local varieties of fruit and small-fruit plants for every region, carried out in the very region for which the new variety is planned, directly in the orchards of its state farms and collective farms. In his work the breeder must strive to solve the most urgent problems set before fruit growing by present-day requirements, i.e., he must produce such varieties as would in the first place contribute to solving the problem of nutrition of the working people; such varieties as would be suitable for the purposes of industry and export trade and afford the possibility of mechanizing fruit-crop harvesting.

4) With the purpose in mind to wrest from Nature more and more new valuable plants for introduction into culture, all measures should be taken for the tireless quest of wild plants worthy of cultivation. In these searches use should be made of the experience accumulated by investigators and at the same time this experience should be increased by exploring the mountains, the forests, the steppes and the marshes of the vast remote regions of our country, particularly those of the Caucasus and of the Far East—the regions that still conceal a great many valuable species that are as yet unexploited.

It is true, that this is a thorny track fraught with many a disappointment for young Soviet fruit growers. All the more, every new discovery will serve as the greatest reward and will win the greatest esteem in the country of working people. Fruit growers will never get off the track if they always follow my firm rule: "We cannot wait for favours from Nature; we must wrest them from her."

The present edition as I have already mentioned, is in fact the third revised and reduced in price edition comprising the first two volumes of

my work *Results of Half a Century of Work in Producing New Varieties of Fruit and Small-Fruit Plants*, that have already been published. It includes only about one-half of the total of my actual achievements in the origination of new improved varieties of fruit and small-fruit plants for the regions of the central zone of the European part of the R.S.F.S.R. The principles and methods of my work are described in this edition, besides it gives the description of the most valuable new fruit-plant varieties that I have originated. These are the new varieties of apple, pear, quince, mountain ash, sour cherry, sweet cherry, plum, apricot, almond, raspberry and actinidia. The description of the remaining new varieties of apple, pear, plum, cherry, apricot, quince, grape, walnut, rose and various species of berry shrubs, as well as the description of many experiments and methods of work has to be deferred until the subsequent volumes are published in the next edition.

CHAPTER 1

THE ASSORTMENT OF FRUIT VARIETIES GROWN IN THE ORCHARDS OF THE U.S.S.R. AND THE MEASURES FOR ITS IMPROVEMENT

The government of tsarist Russia did not care a bit about satisfying the requirements of the working people in respect to fruit and was not much interested in the development of our home horticulture. For centuries practically no measures whatever were taken for its improvement, especially in the central and northern zones of European Russia.

Only occasionally did the individual horticulturists try to do something in this respect on their own initiative, but unfortunately, in pursuing their goal they followed the wrong track. They tried to replenish their assortment of fruit-plant varieties exclusively by introducing into their orchards specimens of already fully-formed best foreign varieties; but since their constitution had been formed in warmer lands, under much better climatic conditions, these properties upon being transferred into our country with its relatively rigorous continental climate, could not grow and develop normally. Despite the application of various measures of the notorious acclimatization, the foreign newcomers suffered, grew sickly and finally perished with very rare exceptions. In the meantime the weakened sickly organisms of those fruit trees afforded a favourable basis for the development of hosts of various pests and thus infested all our orchards with their hardy local varieties, which had never experienced such an invasion of foes. Those rare specimens of foreign varieties that survived in our unfavourable climate degenerated to such an extent that the fruit of many of them became inferior even to our old local varieties in their appearance, taste and yielding capacity. All this in combination with other unfavourable factors gradually contributed to that disastrous decline of our horticulture that we witnessed before the World War. The consequences of that war altogether killed it.

Now we are confronted by a rather difficult but honourable task of great

national importance: in the process of the socialist reconstruction of our fruit-growing economy we must restore and raise in the nearest future the yielding capacity of our existing orchards and therefore, their marketability. We must also create a new socialist horticulture based on the advanced technique, feasible mechanization and strict planning, using for this purpose the well-tried socialist methods of labour—socialist emulation and shock work. The objects of such horticulture is to supply in sufficient quantity cheap fruit of high quality for the working people, raw material for industry and also fruit for export. It is, first and foremost, from this standpoint that the suitability of our old varieties of fruit plants in the assortments of the northern, central and southern zones of former European Russia, the Ural region, East and West Siberia, the Caucasus and Central Asia should be viewed. Any varieties that proved to be of low productivity when cultivated in orchards should be ruthlessly eliminated from further cultivation. That, according to my opinion, unfortunately, would be the destiny of most varieties that are at present cultivated in our orchards. After such a thorough purge it will be obvious to all how poor the lists of our really highly productive varieties actually are, and the urgency of replenishing them by the selection of new varieties of improved quality will become quite obvious.

Without repeating the error of the old horticulturists, who hoped in vain to acclimatize foreign varieties in our country, hybridization and other methods must be used to produce from seeds our own improved and hardy varieties for each locality.

After thirteen years (beginning with 1875) of thorough theoretical and practical study of plant life, and, in particular, of the state and requirements of horticulture in Central European Russia, after having toured and inspected all the outstanding orchards and horticultural institutions of those days as well as on the basis of my personal examination of the qualities and properties of fruit-plant varieties suitable for cultivation in central and northern parts of former European Russia, I came to the conclusion in 1888 that the level of our horticulture was very low. At that time our assortments besides being poor, were contaminated with various semicultivated, sometimes even absolutely wild forms of forest trees. The only varieties tolerably good in respect to productivity that were figuring in the first place everywhere at that time were among apples: Antonovka, Borovinka, Skrizhapel, Anis, Grushovka and the like; among pears—Bessemyanka, Tonkovetka, Limonka; among cherries —Vladimirskaya and its seedlings; among plums—the seedlings of blackthorn and different varieties of damson. Only rarely here and there in the orchards some varieties of foreign origin (variants of Reinette, Calville and Pippin) would be found scattered in small quantities.

Among pears there were absolutely no winter varieties. As for sweet cherries, apricots, peaches and grapes, these fruit plants could be found only in hothouses, and nobody ever dreamed of cultivating these species in the open. With such assortments of varieties no results worth mentioning were to be expected from the orchards.

In the meantime the import of various fruit into the northern regions from the South and from abroad cost the state many million rubles.

A survey of the state of affairs made evident the urgent necessity of radically improving the existing assortments of our orchards. This compelled me to found in 1888 a nursery of fruit plants with the only object of originating new, improved and more productive fruit-plant varieties.

At first I tried to achieve this result by the selection of seedlings grown from the seeds of the best varieties—both our native and foreign. But finally the results convinced me that the new varieties thus obtained had been insufficiently improved. It became evident that the choice seedlings of the best local varieties were but slightly better in quality than the old varieties, while the seedlings grown from the seeds of the foreign varieties in most cases proved to lack hardiness and were destroyed by frost. I had to resort to hybridization, i.e., to make crosses between the most productive and best flavoured but delicate foreign varieties and our hardy local fruiters. Such crosses rendered it possible for the hybrid seedlings to combine the characters inherited from both parents, the beauty and the fine flavour of the foreign varieties and the hardiness of our local cold-resistant forms to the climate of our region.

CHAPTER 2

FALLIBILITY OF THE VIEW THAT SOUTHERN PLANTS CAN BE ACCLIMATIZED BY SIMPLY TRANSPLANTING THEM

I think it will be of benefit to future students of my experiments if I also make mention here, at least in brief outline, of my errors in method and the mistaken conception which I at first had of certain phenomena in the life of plants. In most cases these errors were rooted in the fact that, owing to my then inexperience, I trusted too much to the opinions of the horticultural authorities of those days, and did not test their truth for myself.

Such errors caused me a vast amount of uselessly wasted time, labour and means. Whole decades of unproductive effort were spent unprofitably in the execution of certain details. And it has to be said that even today, after the lapse of more than forty years, survivals of these mistaken notions still make themselves strongly felt at times in the work of some horticulturists, and do undoubted harm. Thus, there is the long-standing belief that grafting onto the crown can hasten the onset of the fruiting period in a young hybrid, or that grafting a tender variety onto a cold-resistant stock can lend it hardiness—this was preached in his time by the well-known Moscow horticulturist Grell. There is also the claim of the botanists of those days that interspecific, and all the more so, intergeneric hybrids are impossible, that if they do sometimes appear, they are bound, one and all, to be sterile, and so on.

Some have claimed that in the central areas of the European part of the U.S.S.R., it is useless even to contemplate the cultivation of winter pears,

grapes, sweet cherries, apricots, peaches and walnuts. All this has proved to be mistaken in one or another degree, and has only been borne out in exceptional cases.

For example, the grafting of a young hybrid onto the crown of an adult tree hastens fruiting in the hybrid only if the latter has itself already entered a period close to fruit bearing. Furthermore, by its vegetative influence, due to the work of the whole crown's leaf system, the adult stock will alter the properties of this young hybrid, in the majority of cases for the worse.

Only as a rare exception, by a chance happy choice of a stock suited to the properties of the hybrid grafted onto it, is the result a success, that is, an improvement in the external and internal properties of the hybrid is obtained. Such a new variety, however, will not have the exact characters which it inherited from the crossed parent plants; its properties will be a combination of these with the properties of the stock, that is to say, a vegetative hybrid will result.

Accordingly, if it is necessary to make such a grafting, circumspection is required in choosing the variety of adult tree that is to serve as the stock.

As the best stock for such purposes, I would name, of the apple trees, the Skrizhapel and its variations, or, better still, young trees grown from its seedlings; and of the pears, the Malikovka, the Tonkovetka and their seedlings.

Well-tried new hybrid varieties, which have already been bearing fruit for several years, and also all long-standing varieties of apples and pears, both native and foreign, do indeed begin to bear fruit much sooner when grafted onto the crowns of adult trees; and, moreover, if the influence of the stock affects their properties at all, it does so only in a barely perceptible degree which is of no practical importance.

Of course, there may be exceptions here too. Thus, a cutting of the 600-gram Antonovka, grafted onto the crown of an adult specimen of the small Siberian crab, produced fruits of a cylindrical shape totally alien to the Antonovka.

Again, a cutting of the Malikovka pear, grafted onto the crown of an adult of the new Bergamotte Novik hybrid, yielded fruits twice the usual size, etc.

Next let me deal with the mistaken view that foreign varieties of fruit which lack resistance to our frosts can be acclimatized by supplying them with cold-resistant stocks.

That this belief of Grell and his disciples—Romer and others—is a delusion, is altogether obvious.

Varieties propagated in this manner perished from the cold with the greatest regularity. But here too exceptions occur, although very infrequently.

Occasional specimens which strike by accident upon stocks with an exceptional individual power of influencing the scion, in respect of imbuing

it with their own hardiness, do become hardy. Such young trees grow to maturity and sometimes bear fruit for several years.

But this cannot be described as acclimatization, if only because, when it is attempted to propagate such plants by cuttings, the latter usually prove to lack hardiness and are killed by frost in the first few winters.

As to the very few foreign southern varieties which have proved fairly resistant to our frosts, this can be explained by their having already possessed, in their native countries, a capacity for resisting temperature drops below the usual range of warmth and cold fluctuation in those countries.

When transplanted to our parts, such varieties endure our climate with comparative ease. But what has acclimatization to do with it?

This is commonly termed the naturalization of plants in a new environment.

CHAPTER 3

METHODS OF PRODUCING NEW VARIETIES AND THE SIGNIFICANCE OF A SPECIAL REGIME FOR TRAINING HYBRIDS

The breeding of new and improved varieties of fruit trees and small-fruit shrubs grown from seeds is effected by one of three methods iterated below.

The first consists in a simple selection of seedlings grown from the seeds of the best local varieties which happen to possess good fruit qualities and can stand the climatic conditions of the given district. All the assortments of the orchards of former Northern and Central Russia and of almost all the neighbouring Western countries have been built up by such "chance varieties." In the peasant Anton's kitchen garden, for example, an apple tree grew up from a stray seed. The apples were large and their taste was good; thus, from that time on people began to breed this variety and called it Antonovka. In the Volga Region another variety was found that likewise grew up from a seed fortuitously sown; this new apple had prettily coloured fruits and its flavour faintly reminded one of anise, so it was named the Anis; the same is true of the various Borovinkas, Grushovkas and such pears as the Tonkovetka and Poddulka. In Western countries varieties were collected much in the same way: for example, in Belgium, from a seed of a cultivated variety that had been accidentally dropped in the forest by bird or man, a tree grew up that bore fruit of excellent flavour and size; hence this new variety was called Forest Beauty [Fondante de bois], etc.

Many persons, as for example, Van Mons and parson Hardenpont in Belgium, Tourasse in France, Ross and Veitch in England, and, finally, in Russia on my initiative and advice, Kuzmin, Kopylov, Spirin; and on their own initiative in Siberia Neznayev, Komissarov, Prof. Kashchenko, Bedro, Nikiforov, Krutovsky and others began deliberately to sow seeds of their best varieties and then select saplings with better fruit that may have accidentally grown from them.

Thus gradually in the course of a few hundred years all the orchard assortments of fruit trees were formed.

But work with this method, based as it is on chance findings of trees of good quality, may be carried on only in districts with the favourable climatic conditions of warm Western countries or in California where the well-known originator, Luther Burbank, has been working lately. Under a warm climate, and particularly if mass planting is practised, such chance findings of better varieties as well as much valuable material may be obtained without any particular effort on the part of man. But in our country, particularly in the northern and central belts of the U.S.S.R., under our severe climatic conditions and comparatively short vegetation period such a method will not get one far ahead.

From the planting of seeds of our local varieties we can only obtain fruit of the same quality with but very few casual improvements. In general, very slowly, in the course of several centuries by breeding many generations of plants much improvement may be achieved in our country as well; this is evident from the history of the development of horticulture everywhere. But the contemporary rapid pace with which the various phases of man's life evolve makes it impossible to wait so long for improvements.

Most of the seedlings raised from the seeds of the best foreign varieties, with very rare exceptions, will prove to be non-resistant to our frosts, and as a result we shall not be able to improve very much the varieties of our fruiters.

Let us now turn to the second method of solving the problem which gives much better possibilities of augmenting the quality of new varieties of fruiters. This method is based on the introduction of so-called hybridization, i. e., crossing. Since each plant organism usually contains male and female reproductive organs by means of which it produces its offspring, it is possible to improve our hardy local varieties by crossing them with foreign ones that had been raised in a warmer climate and which yield fruit of better quality as compared with our own, but are unable to resist our frosts. From such crossings fruit are obtained the seeds of which are sown and seedlings raised; from these seedlings we select the specimens which, as far as it can be judged from their external characters, had inherited from their parents the improved fruit flavours inherent in the foreign varieties, and the resistance to frost characteristic of our varieties. By such a method qualitatively improved new varieties are obtained that are able to stand the conditions of our region.

However, although the second method gives the greatest percentage of improved new varieties, it nevertheless does not provide for all the ways of man's purposefully alterating the structure of hybrid seedlings.

It is likewise necessary to take into consideration all changes in the structure of hybrid seedlings, which I shall deal with later on.

The influence of external factors as well as the combination of hereditary factors obtained from distant ancestors will here become manifest. Besides, the results obtained from the crossing of the same pair of progenitors will

never be repeated twice; in other words, if we cross a pair of plants and obtain hybrids with a combination of certain properties, no matter how many times we repeat the cross with the same plants, we shall never obtain hybrids of the same structure. Even the seeds in one and the same fruit obtained from the cross give rise to seedlings of completely different varieties. It is evident that in creating new forms of living organism Nature gives rise to infinite diversity and never permits repetition.

As a result of these circumstances every originator (a person who is occupied with the production of new varieties) must content himself only with making use of the combined influence of all the internal and external factors, since he cannot possibly know what properties all the ancestors of a given pair of parent plants possessed, and since he is unable to control the influence of external factors. Therefore, in these cases it is not only impossible to apply any kind of Mendelian calculations, but it is likewise impossible to work on the basis of strict preliminary planning in the production of two varieties of fruiters closely resembling each other. And if my conclusions are erroneous on this point, I beg to show me the firm basic principles which could lead me out of the labyrinth of misunderstanding. Only please don't offer the usual unconfirmed hypotheses; I myself can offer a whole set of them, but they are absolutely of no aid in practice.

Furthermore, in the work of producing new varieties of fruiters the third method should be regarded as the most important one; it consists in repeated crossing of the hybrids to the best cultivated varieties (including foreign ones).

When applying this method we may follow the lines of giving the proper training to the seedling during its development. Namely, in most cases we may enhance the development of useful characters and weaken or altogether suppress the development of harmful ones, basing judgment on the external manifestations of both. When carrying out such work we are partly guided by scientific data, but in most cases there are none to go by, so that we are obliged to base it on experience gained by many years of labour.

Many persons, having erroneously interpreted the term "segregation of the parent types" expect good results from the planting of hybrid seeds in the second generation, hoping by this means to secure a repetition of the foreign variety structure but of a more resistant type.

But, in the first place, in the course of my practice of many years after numerous experiments on planting hybrid seeds of perennial fruiters I have, in general, never met with an exact repetition of the structure and form of the parent plants. Evidently Nature does not permit the repetition of form; always plants are obtained with new combinations of properties and characters. There cannot be complete segregation of parental types simply because the form of each hybrid, as I have already repeatedly stated, is built up by a mixture of inherited characters, only a small part of which comes from its direct parents, whereas the rest come from their kin. Secondly, the structure of each hybrid in the course of its development from the time of its germination up to its first years of bearing in most cases is greatly altered

under the influence of external factors, which also eliminates the possibility of repetition. Besides all this, the properties of the seedlings of the second generation grown from seeds that were obtained from self-pollination of the hybrid (without repeated crossing to the best varieties) always deteriorate or are completely lost due to the repeated deletorious influence of our climatic conditions.[1]

Quite the opposite results are obtained if the hybrid is repeatedly crossed to the best foreign varieties; here in most cases a considerable general improvement is observed both from the introduction of a new variety into

Fig. 34. Pollinating apple blossoms in the orchard of the Plant-Breeding and Genetics Station in Michurinsk

the cross possessing new and desirable qualities and from the greater susceptibility of a young hybrid, particularly one that has been standing on its own roots.

Of course, all these rules cannot be applied to the hybrids of local fruiters belonging to pure species or to hybrids of local grain cultures, or to annual vegetables; these may, after all, manifest improvement in the second generation. There can be no great difference between the properties of the ancestors and those of the hybrid obtained from the crossing of local pure species of fruit trees. As for annual field and vegetable plants,

[1] As factual proof of this phenomenon in my nursery there is a whole series of trees belonging to the second generation.

in most cases the continued action of external factors during postembryonic development is absent. Thus, in hybrids between pure species of rye, wheat, oats, peas, millet, etc., I consider the "phenomenon of segregation of the parent types" to be quite possible. The Mendelian laws are applicable here in many details.

I shall cite one of the many hundred examples. In 1900 I fertilized the flowers of the apple *Malus Niedzwetzkyana*—a pure species—with the pollen of Antonovka. The former is remarkable for its marked red colouring of both leaves and fruit. As a result, one fruit set and ripened, from it I obtained fourteen seeds, and in due course the following types of seedlings: six with red leaves and seven with green leaves, and one had one side of its shoots and leaves coloured red and the other green. Both the red and the green seedlings developed with the usual vigour, whereas the striped one (evidently due to the difference in the structure of its cells on both sides) at first grew very sparingly—was about half the size of the rest, but gradually the red colouring expanded, and when it finally encircled the circumference of the trunk, the growth of the sapling increased and the tree reached the height of the others. Finally, in 1914/15 all the trees bore fruit; it so happened that the seven red trees produced fruit of about the same size, but twice as large as those of the mother plant, all of the winter type and of approximately the same flavour. The seven green forms produced fruit that greatly varied in size, shape, colouring (for the most part pale and designed) and flavour—from very sweet to extremely sour, a property not met with either in the paternal plant—Antonovka, or in the mother—the Niedzwetzkyana apple. Such a diversity of types was evidently the result of the manifestation of the recessive characters of Antonovka's distant kin. Furthermore, from the self-pollination of the seven red hybrids due to the dominance of the Niedzwetzkyana pure-species type trees were obtained the fruit of which had an extremely red flesh. On the other hand, if the flowers of the red hybrids were pollinated by any green hybrid or by any other cultivated variety, the trees produced from the cross yielded fruit that were coloured only from the outside, whereas the flesh remained white and was of a miserable flavour.

When the pollen of the first red hybrids was used to fertilize the different cultivated varieties the resulting hybrids yielded fruit of completely red colour but only of the rind; their flavour was excellent and always of the winter type. The latter property was the result of the shorter period of vegetation in our parts as compared with the longer period necessary for the Niedzwetzkyana apple. The seedlings of the first seven green hybrids when self-pollinated, yielded in the second generation only typical wildings; the same occurred when they were crossed with cultivated varieties. Here it is evident that the recessive characters of Antonovka's wild ancestors proved to be dominant. Now just how is one to apply Mendel's laws in such a case?

In the cited instance if we consider the increased size and better flavour of the fruit from the first-generation red hybrids as the result of the in-

fluence of the Antonovka characters, then where does the diversity of types obtained from the green hybrids come from? Particularly, since they failed to manifest a single character of their parent plants. Furthermore, why does the pollen of the red hybrids when used to fertilize other old cultivated varieties, despite its dominance, produce fruit of good quality, whereas the pollen of the first seven green hybrids produces only wildings? Even if segregation does take place, in this case, at any rate, half of the characters belong to Antonovka's very distant past and not to the direct and immediate parents of the hybrids.

One point is clear, namely, that the characters of the Niedzwetzkyana apple, being those of a pure species, in all cases prove to be strongly dominant and suppress and leave in a recessive state most of the characters of other varieties. The cited case likewise demonstrates one of the reasons for dwarfed growth, proving it to be due to the correlative influence of the incongruity of structure and growth of the cells in the different halves of the plant; externally no other characters were manifest except the red colour of the bark.

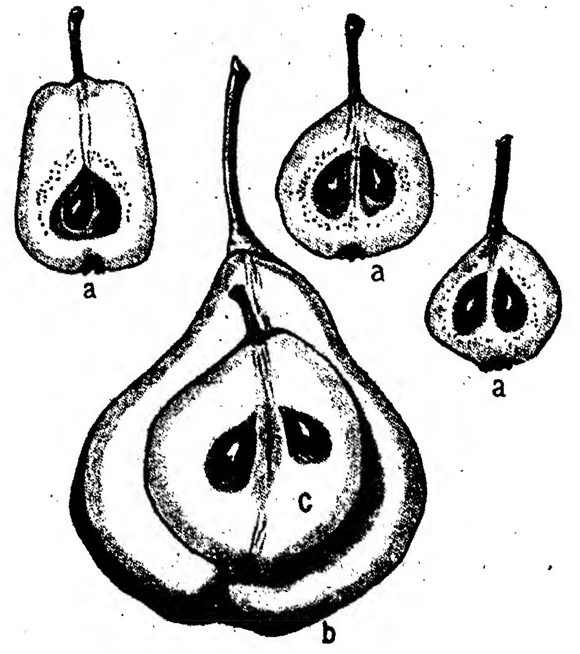


Fig. 35. Hybrid of *Pyrus salicifolia Pall.* with Bessemyanka; a—fruit of the *Pyrus salicifolia*; b—fruit of the Bessemyanka; c—fruit of the hybrid

A second example: in 1903 I fertilized the flowers of *Pyrus salicifolia Pall.* with the pollen of the Bessemyanka pear; the former produces small, very hard and inedible fruits of a grey colour and with long and narrow leaves covered on both sides with a white pubescence. Six seedlings were obtained the external appearance of which sharply manifested a complete mixture of characters of the two parent plants. The shoots were of a light colour, the leaves in shape were half-way between the leaves of Bessemyanka and *Pyrus salicifolia*. In 1918 one of the hybrids bore pear-shaped fruit of medium size with a very watery and sweet pulp [see Fig. 35].

CHAPTER 4

CONDITIONS FOR SUCCESS IN OBTAINING NEW VARIETIES BY MEANS OF HYBRIDIZATION

The results of my long experience have shown that for a successful production of new varieties by means of hybridization the following circumstances should be always had in view.

1. First of all, the qualities of each hybrid grown from fruit seeds that were obtained from the cross of two parent forms will be represented by a combination only of that part of the hereditary properties transmitted to it by its parents and their kin which found favourable conditions in the environment (air and soil temperature, the amount of atmospheric electricity, the direction and the force of the ruling winds, intensity of light, soil composition and moisture, etc.) for their development from the earliest stages of the hybrid's growth. Therefore, the organism of each hybrid seedling is a sum-total, and its items are the characters of the parent plants and their kin plus the influence of external factors. All these conditions are ceaselessly and constantly changing, so that not only unlike hybrid forms arise at different periods from the crossing of one and the same parent plants, but even separate seeds from one and the same fruit produce hybrids that completely differ from one another in properties. In general, a repetition of the same form is never met with in hybrids of perennial fruit plants; this is more or less possible only in seedlings of pure species.

On the ground of my recent observations I have come to the conclusion that it is impossible, with rare exceptions, to obtain completely constant varieties of cultivated fruit plants by natural sexual propagation (by means of seeds) because it is impossible to have plantations of only one selected variety that would be protected from cross-pollination. In such cases the simplest method of propagation is the rooting of layers only: This will be dealt with later on.

2. The more distant are the parent plants used in the cross with respect to place of origin and environment the more easily adaptable will their hybrid seedlings be to the external conditions of the new locality. I explain this by the fact that in such cases the properties inherited by the hybrid from its maternal and paternal parent and from their nearest kin, not finding the usual conditions to which they had been accustomed in their place of origin will not be so dominant as to manifest themselves one-sidedly in the development of the hybrid organism, which is of enormous significance in practice. For a clearer understanding of this phenomenon I shall cite an example from my investigations. When crossing foreign varieties of winter pears with our Tonkovetkas, Limonkas and other hardy varieties hybrids are obtained with better taste qualities, but all of them are early-maturing forms and have small-sized fruit due to the dominance of the characters of our local varieties for the development of which the climatic and other conditions of our regions are appropriate and usual. On the contrary, when

I crossed the foreign winter pears with the wild Ussurian pear [*Pyrus ussuriensis Max.*], which I had raised from seeds obtained from Northern Manchuria, one-half of the hybrids had large fruits of excellent flavour that ripened in winter storage; all the top part of the plants were perfectly resistant to our frosts. The second half of the hybrid trees manifested properties of the foreign variety, were non-resistant to frost, and what is more interesting, the quality of their summer-ripening fruit, both in flavour and in the insignificant size, was very low—a property of the Ussurian pears.

3. All fruit plants that are not grafted but have their own roots when crossed give a greater number of cultivated varieties with good qualities as compared to those that are grafted to wild stock. This clearly shows that the plant's root system plays a very active part in the formation of the seed. That is why my first crossings of apple I began with young seedlings of *Malus prunifolia Borkh.* in their first blossoming, and after that, when the hybrid trees were raised and new varieties could be distinguished, the subsequent crossings were effected with the saplings of the new varieties grown from seeds and standing on their own roots.

4. The age and health of the parent plants chosen for the crossing are of very great significance in practice. Young hybrid plants in their first bearings, or older plants that have been bearing for many years but which were weakened by a dry or unusually cold spring during the given vegetation period, possess a weaker individual capacity for hereditarily transmitting their properties, and, conversely, plants belonging to pure species and, particularly, wild forms in their prime, possess the greatest capacity of handing down their properties to the hybrids. Thus, for example, from the cross of the Crimean Kandil Sinap with the Siberian crab apple [*Malus baccata Borkh.*] hybrids were obtained with fruits the size of our ordinary orchard Kitaika [*Malus prunifolia Borkh.*], whereas the cross between Kandil Sinap with the seedlings of our orchard Kitaika in its first blossoming produced fruits of an excellent taste. In this case the maternal parent was the young seedling of the Kitaika, not the pure type of course, but a hybrid; this became evident later from the larger size of its fruit as compared with the ordinary size of the Kitaika. That is why its resistance properties were not transmitted with due intensity, and as a result the shoot ends of the seedlings obtained from this cross suffered from the frost. To eliminate this shortcoming the hybrids had to be placed once again under the influence of their female parent—*Malus prunifolia Borkh.*—by grafting cuttings of the seedling into the crown of the maternal tree, which soon gave the required degree of resistance to the new variety. This circumstance should be taken into consideration when choosing the parent plants.

It has been likewise remarked that flowers chosen for fertilization on the maternal plant, if placed nearer to the main vertical branches of the trunk, give better hybrids with larger-sized fruit but such that tend to deviate considerably in structure in the direction of the maternal plant, and, conversely, flowers on the horizontal branches, placed nearer to the periphery of the crown generally give hybrids with fruit of smaller size and such

that deviate in the direction of the male parent. The shady side of the maternal plant yields hybrids of poorer quality as compared to the sunny side. This is particularly clearly expressed by the depth of the outer colouring of the fruit and by the amount of sugar in the pulp.

5. Under the climatic conditions of our localities, when raising new varieties from seeds obtained from the crossing of delicate foreign varieties with our local hardy species or when simply sowing the seeds of fruit plants from warmer countries (as compared to the region where the seedlings are grown), the seedlings should in no case be given too rich a soil; particularly, fertilizers that increase the growth of the seedling should be avoided, otherwise the properties handed down by the varieties of the warmer climate will be too dominant in the development of the hybrid. As a result, delicate seedlings are obtained with a friable structure of the wood which fails to mature sufficiently and to finish its growth on time before the fall and, consequently, practically all such forms perish. These are the reasons in most cases for the failures to raise new varieties from seeds which so many amateur horticulturists in our districts have attempted; this is particularly true of Siberia where the soil is extremely rich and virginal.

I myself have committed the same error at the beginning of my career by trying to produce luxuriantly growing hybrid seedlings. Within a few years I lost hundreds of them due to freezing, until at last I resorted to especially prepared lean sandy loam for the beds where the sowing and the pricking out were effected. Of course, when selecting one-year-old seedlings raised on rich soil a greater number of better trees was obtained, but all of them proved to be totally unfit for our districts due to lack of resistance. Those that had been reared in severe conditions on the lean soil, proved to be completely resistant to frost, although the number possessing excellent varietal properties was smaller. The necessity for such training of hybrids became so clearly evident in practice, that I was obliged to sell in 1900 the plot of black earth which I had used for a nursery and to look for another plot of lean sandy loam for it. Otherwise I would have never succeeded in producing new varieties of fruiters and in introducing new types of plants into culture in our parts.

Here it is necessary to turn our attention to the very essence of the problem of raising new plant varieties: its aim, you know, is to obtain fruits of better flavours and not trees with the most luxuriant growth; I repeat, an orchard must yield fruit for food and not wood for fuel.

I begin to apply manures only at the stage when the young hybrid plant normally begins to form reproductive organs, i.e., the fruit buds. At this stage manuring becomes essential both for the increase in the number of fruit buds that are more fully formed and for the development of larger fruit. When the plant has reached the stage of maturity, fertilizers cannot do harm because the seedling has already acquired comparative stability to changes in all parts of its body with the exception both of the seeds, which are being formed in the fruit for the first time, and of the pericarp. It is the develop-

ment of the latter two that is enhanced by the manuring. But even here mineral fertilizers should be usually preferred to organic ones so as to avoid infecting the plant with rot and parasitic fungi which, according to my repeatedly checked observations, often happens to trees of winter varieties of apples and pears. In all stone-fruit cultures organic manures lead to gummosis; this is particularly manifest in sour and sweet cherries, where surplus mineral fertilizers such as lime are harmful because they enhance the development of the stones to the detriment of the quality of the fruit.

Organic manures may be applied to shrub small-fruit cultures such as the gooseberry, raspberry, currant, etc., during all stages of their development.

In general, it should be known that the luxuriant growth of a plant in most cases does not accelerate the onset of fruiting, this has been well known to horticulturists for a long time. If a fruit tree grows intensively, "lays no eggs" as the horticulturists say, it fails to bear. The separate vegetative shoots in the tree's crown remain barren for a long time. As to contrary opinions such as the work of Tourasse in southwestern France in the eighties of the last century, early fruiting in pear seedlings was a mere coincidence and not the result of accelerated growth due to increased nutrition, as he asserted. I, too, witnessed such cases of premature fruiting in two-year-old hybrid pears, apples, cherries, walnuts and chestnuts, but in most cases the subsequent growth of such plants either proved to be abnormal or their fruit buds would be damaged by the frost or would simply develop into shoots. Thus, for example, in two-year-old peach seedlings a premature development of fruit buds was a sure sign of a particular lack of resistance to frost. In other words, this phenomenon should be regarded as pathological, which is proved by the fact that such plants are short-lived; I have not been able to preserve a single specimen. Only at the age of five-six years was the onset of fruiting normal in some of the specimens.

6. The artificial induction of excessive fruit size in specimens obtained from the cross is likewise to be avoided, since the seeds from such abnormally large fruits or, better to say, pericarps are in most cases underdeveloped, meagre and as a rule give rise to forms with small-sized fruit. For example, the seedlings grown from the seeds of an extremely large pear (almost 600 grams) Beurré d'Hardenpont taken from a trained tree gave fruit of excellent flavour but weighing no more than ten grams, whereas seedlings grown from seeds of a 300-gram fruit from the same tree yielded fruits weighing 150 grams. The same is observed in other plant species and varieties.

7. When crossing the best foreign varieties with new and improved hybrid varieties of recent origin, the latter, although lacking sufficient power of hereditary transmission due to their juvenility, nevertheless give good results as maternal plants, if only because their nearest kin possessed fewer negative qualities.

8. When choosing frost-hardy plants for crossing with delicate foreign plants it is insufficient to take into account only the severe conditions of their place of origin. It is likewise essential to consider both the soil conditions and the length of the period of vegetation. Otherwise it may so happen that plants,

able to resist a 45°R. frost in their native country, freeze in our districts at −25°; this happened to the Nerchinsk apricot (*Prunus sibirica L.*) that grows on the mountain slopes in the environs of the town Nerchinsk in Siberia. In Michurinsk seedlings of this apricot always perish during their first winter. In this case the freezing is explained by the fact that this apricot is accustomed to the short summer of its native land and to the dryness of the mountain slopes. In our parts (if it is not planted on a steep hillside), in the middle of the summer its growth is finished and towards autumn a second flowing of sap begins, and, being unable to "gather it in" again, the plant freezes. Conversely, I have come across facts that are hard to explain, for example, the following: In 1888, from the cross of the Winkler White Cherry with the Vladimirskaya Rozovaya cherry I obtained a new hybrid variety—a large-fruited pink sour cherry, which I named Krasa Severa; this excellent variety was an interspecific hybrid between *Prunus Cerasus* and *Prunus avium L.* and during its first years in our regions the ends of its shoots suffered from frost; when transferred to Siberia in Omsk it sustained the Siberian frosts and fruited abundantly, whereas the ordinary European varieties of *Prunus Cerasus* and even the half-wild Vladimirskaya Rozovaya sour cherry freeze completely in those parts.

9. It is impossible to know beforehand with certainty what the result of the crossing of two parent plants will be, if only for the reason that not only do crossings of all cultivated varieties of fruit plants of hybrid origin manifest completely unexpected atavisms (the appearance of properties characteristic of their remote ancestors), but also because the same is true of crossings between pure species. Thus, for example, a pure species of Siberian currant (*Ribes diacantha Pall.*) growing for several years in my orchard, gave seedlings of its own typical structure, but in 1924, after having been self-pollinated, produced seedlings which were all very much like the species *Ribes pubescens*, that is, like the pubescent Siberian currant, although there was never a single specimen of it in the nursery. In general, it has been noticed that seedlings acquire through heredity not only the characters of their direct and immediate parents, but a mixture of the characters of their kin along the paternal and maternal lines.

It follows from what has been said above that all preliminary exact calculations and plans in hybridization are a waste of time, the more so because the influence of external factors plays a considerable part in the habit of the hybrid seedlings, and it is impossible to know beforehand their potency and composition. Besides, it is beyond man's power to eliminate completely such as may be undesirable.

10. As to the influence of external factors I must say that at present it is impossible to compute with exactitude their diversity and number in all its magnitude; it is likewise difficult to make an evaluation of their action upon the structure of the plant organism. For the time being we may confine ourselves to the following:

a) In general, the influence of the sum-total of external factors on the structure of the hybrid organism is so great, that in most cases it overrules

the action of the characteristics and properties hereditarily transmitted by the parent plants. In particular this influence manifests itself in the mother plant at the time when seeds of the future hybrid organism are being formed, and in the resulting hybrid during its earliest stages of development favouring some and serving as insuperable impediment for the manifestation of other hereditary characters. And almost always the degree of success in crossing plants solely depends upon such influence.

b) When the springs are warm, temperately moist and mild the number of crossings with good end results is highest. Under such weather conditions the characteristics and properties of the best foreign varieties that had been formed under the favourable factors of a warm climate are more fully handed down to the hybrids in our region.

And, conversely, the years when the springs and summers are cold, rainy and stormy are unfavourable for the transmission and development of the best properties of the foreign varieties, with the result that the lower qualities of our varieties, characteristic for our comparatively severe climatic conditions, will in most cases be dominant in hybrids produced during such periods.[1]

c) Heavy clouds and frequent precipitations, the prevalence of cold north and dry east winds, late morning frosts greatly hinder successful hybridization.

d) The excess watertightness of cold, heavy soils, the proximity of subsoil water likewise exert a harmful influence.

e) Localities that are not proof against strong air currents and are open to wind are no good for the growing of hybrid seedlings.

Here are the principal facts which I in the course of my sixty years of experience have been able to note as essential for a better approach to the problem of raising from seeds new and improved varieties of fruit plants for our region.

Of course, it would be too bold on my part, putting it mildly, were I to claim that such a way of tackling the problem is a completely scientific one, as one learned Siberian horticulturist has declared about his own work. But, on the other hand, to say that all my new varieties have been produced without any scientific basis whatsoever, "illegitimately" so to speak, as most theoreticians and complete ignoramuses in practice are apt to declare, would be altogether ridiculous, if only because contemporary science has been unable to give the needed instruction upon which such work could be based. No combined efforts will be of any use until a firm basis will be found in future investigations.

All the investigations of contemporary science in our sphere have as yet resulted mostly in unfounded hypotheses which are of no use in working the

[1] But, on the other hand, hybrid varieties raised from seeds and developing during their first years under conditions of comparative cold give a much greater percentage of resistant individuals, than when the springs are warm and the summers hot. Comparatively dry vegetation periods likewise sponsor resistance, and vice versa.

problem. The trouble is that when a breeder fertilizes a flower of a chosen variety of fruit plant with the pollen of another variety he obtains from the seeds of one and the same fruit seedlings of different types, which manifest not only the characters of their direct and immediate parents, but also the characters and properties of both near and distant kin of the parent plants which are in most cases altogether unknown to the breeder; to this must be added the changes that arise under the influence of external factors as well as the diverse sport bud deviations.

The question arises, in what way under such conditions can the laws of Mendel or the hypothesis of the role of the chromosomes help in the matter?

I by no means deny the merits of the Mendelian law. On the contrary, I merely insist on the need to introduce amendments and addenda into it, for it is evident to everybody that his calculations are not applicable to cultivated varieties of fruiters, for when crossing separate varieties of them, the structure of the hybrids is not due to the hereditary transmission of the characters of the direct and immediate progenitors, but in most cases of those belonging to the ancestors of the parent plants, unknown to the originator. In addition, it is due to the influence of external factors, which not infrequently introduce the utmost perturbation into the organisms of the hybrids not only at the initial stage of seed formation after the cross, but also cause the manifestation of sport deviations within the several years during which the hybrids grow to full maturity. It should be added that the greater part of these influences of both internal and external factors are beyond the control of man.

It would be quite a different matter if we were to cross not the cultivated varieties of perennial fruiters whose ancestors are unknown to us, but pure species of wild fruit plants such as *Malus baccata Borkh.* or *Malus Niedzwetzkyana*, or varieties whose characters do not fluctuate, such as the long-standing varieties of annual grain cultures: rye, wheat, millet, buckwheat, peas, flowering herbaceous plants. Of course, in these cases it is worth while taking into account Mendel's laws and even the chromosome numbers. But not only is it impossible to refer to this category all cultivated varieties of indisputably hybrid origin, but even many wild forms of plants that are considered belonging to pure species such as our forest apple *Malus sylvestris Mill.*, the orchard *Pyrus prunifolia W.*, the wild pears *Pyrus communis L.* and even the Ussurian wild pear *Pyrus ussuriensis Max.*, cannot come under this head. All these plants manifest a marked diversity of qualities and properties. It is very difficult to find two plants belonging to the same wild species that would be exactly alike in appearance, flavour and size of fruit—so great are the fluctuations within these species. The seedlings obtained from the seeds of these species, likewise in most cases differ in structure, which at present makes impossible any preliminary calculations of the results of crosses with such plants.

It therefore follows that we are incapable of choosing parent varieties for crossing on any scientific basis whatsoever; we must be satisfied with an

approximate calculation of the fitness of a given variety based on the judgment of the individual properties which it outwardly manifests. At the present moment man can only approximately choose the parent pairs, select the best hybrid seedlings and then properly train them. This is all that we can do at present with the aid of our practical knowledge and methods; as to assistance from science we can expect it only some time in the future.

CHAPTER 5

DISTANT (INTERSPECIFIC AND INTERGENERIC) CROSSINGS. THE METHOD OF VEGETATIVE APPROXIMATION

The erroneous assertion made by botanists of the past that the crossing of plants belonging to different species and genera cannot be applied and that hybrids thus obtained are always barren for many years deprived me of the possibility of introducing hybridization on a larger scale.

Only after having accidentally come across interspecific and intergeneric hybrids of cultivated plants among my F_2 hybrid seedlings did I turn to artificial crossings of plants belonging to different species and genera. Although the success of this work was slow in coming as compared to the usual crossing of plant variations belonging to one species, nevertheless the results obtained were of considerable value.

Furthermore, in the course of the work the following points became evident, namely, that:

1) interspecific crossings can be effected with greater facility when the female parent is a young hybrid in its first blossoming and not a pure species type;

2) a method which I called "preliminary vegetative approximation" is of great assistance in such crossings; it consists in the following: a few cuttings[1] are taken from one-year-old hybrid seedlings and are whipgrafted on to the branches of the crown of a mature tree belonging to a different species or genus, as for example: a pear on an apple, a mountain ash on a pear, a quince on a pear, an almond, apricot, or peach on a plum, etc. Only a few of the grafted cuttings, particularly in stone cultures, join with the stock.[2] During

[1] That is, cuttings of hybrids obtained from the crossing of two varieties belonging to one species; the hybrids must be of recent origin, and such as had not yet fruited; the cuttings from our old varieties of fruit trees should not be used.

[2] Not all cuttings are able to take root. For example, some of the varieties of pear have no attraction for quince, and the reverse; or certain hybrids of almond and cherry fail to join well with plums and vice versa. But in our nursery there are cases of good coalescence even between plants belonging to different families; for example, my closest assistant P. N. Yakovlev has been able to induce coalescence between a lemon and a hybrid seedling of the pear Michurin Beurré Zimnaya.

the following five-six years such cuttings continue to develop under the constant influence of the work effected by the entire leaf system of the stock and gradually begin to change partially in structure up to the time of blossoming; this facilitates the subsequent crossing.

It has further been ascertained that the sterility of interspecific hybrids is not constant in all cases. On the contrary, there are many hybrids which may not give seeds capable of germinating during their first fruit bearings, but in the years following, by gradually improving their structure, it is possible to obtain completely germinable seeds.

Fig. 36. Grafting mountain ash onto quince for vegetative approximation

I shall cite an example of an interspecific hybrid between the yellow lily (*Lilium Szovitsianum Hort.*) and the red (*Lilium Thunbergianum Roezl. & Schult.*). The hybrid which I named the Fialkovaya Lilia (Orchid Lily) because of its beautiful purple flowers and its orchidlike scent during the first two years of blossoming failed to produce seed balls; on the third and fourth years seed balls appeared, but with empty seeds which of course failed to germinate. Only in the seventh year did the plants begin to produce seeds that would partly germinate. The same was observed when planting the seeds of a black hybrid mountain ash, obtained from the cross of *Sorbus melanocarpa* ♂ × *Sorbus aucuparia* L. ♀. For seven-eight years from about a thousand seeds of this hybrid only one or two seedlings would arise; but in 1924 mass germination was suddenly obtained. Among the seedlings quite a number considerably varied in structure.

Furthermore, the same may be said of the vegetative hybrid between an apple and a pear; as a result an excellent new variety of apple was obtained which I named Reinette Bergamotte.

Then again, in some cases the sterility of certain hybrids was eliminated. Thus, the hybrid between *Prunus Padus Maackii* × *Prunus Cerasus* blossomed but failed to fruit. When it was budded on to a sweet cherry stock with the aim of augmenting its vigour under the influence of the stock—the supplying of a mentor as I call it—on the following year all the flowers of the grafts set fruit which developed completely. In general, even most of the sim-

ple hybrids fail to set fruit at their first blossoming, and even if fruit are formed their seeds sometimes fail to germinate; only in the years that follow do these shortcomings in development gradually disappear.

I could add scores of other examples to those cited above from my own observations and hundreds from the investigations of others, but I believe

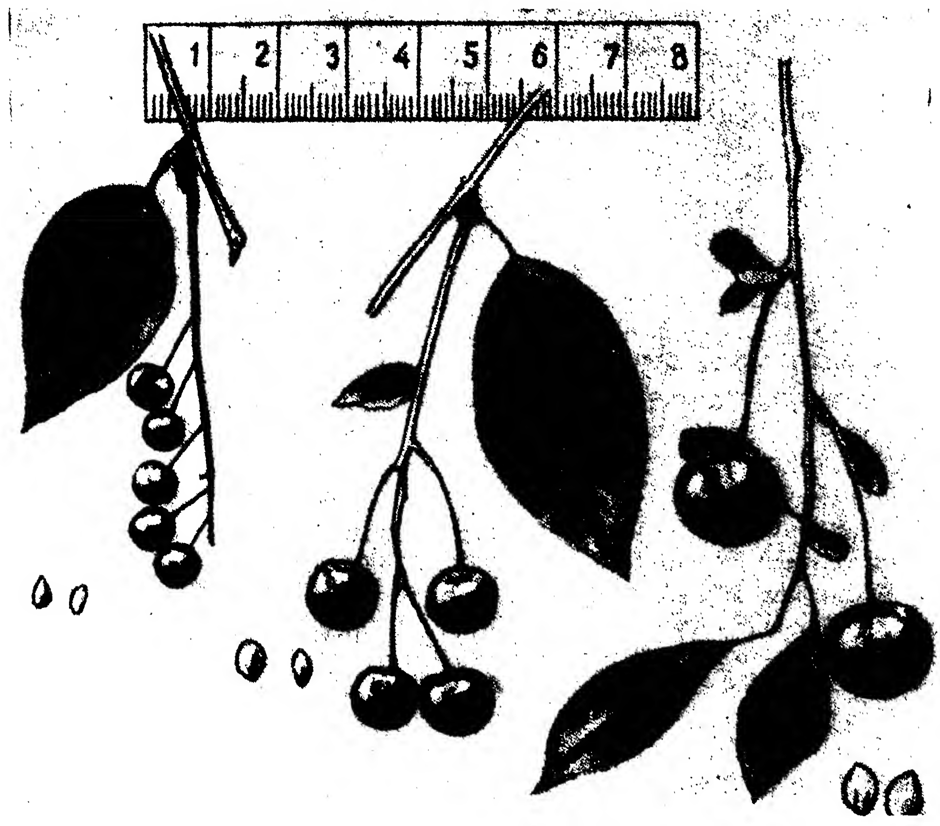


Fig. 37. Interspecific cross of *Prunus Padus Maackii* (left) × *Prunus Cerasus* (right). Hybrid in centre

that these are a sufficient proof of the veracity of my conclusions on the matter. As to citing examples from and referring to the works of other authoritative investigators I consider it rather risky, since the main point of their achievements may be misrepresented.

Besides, it is generally not my custom to sprinkle my works with references to the investigations of others, if only because many of the postulations of authoritative persons are not very sound.

In general, I am opposed to all forms of pedantry and consider the propping up of my investigations by references to the works of others a form of needless cowardice in the face of criticism.

CHAPTER 6

THE NATURE OF BLENDING OF PARENTAL HEREDITARY CHARACTERS IN HYBRID SEEDLINGS OF FRUITERS

When investigating the application of Mendel's law to the hybridization of cultivated varieties of fruit plants, I recommend that, as a beginning, the investigation be confined to observing the hereditary transmission of one of the two characters, just as Mendel himself did in his work on peas. I find it particularly useful to indicate a few of the best and in every way exemplary experiments in hybridization.

In these experiments a proper choice of the pair of parental plants, i.e., of both the male and the female parent, opens a wide opportunity for carrying out simple and precise observations from the very beginning. Quite suitable for this purpose are such characters as the colour and the shape of hybrid seeds, the intensity of the colour of cotyledons, also—the colour of leaves, shoots, and flowers and, finally, the shape, structure and colour of the fruit. Occurrence of some of the above-described mutually correlated changes in structure due to a distinct manifestation of some characters, that had hitherto been in a recessive state, may occasionally be observed in the course of these studies.

Here there is great scope for applying the whole Mendelian calculus to the entire complex of characters of each hybrid.

Furthermore, it can be ascertained in the course of these experiments that if the pair of parent plants belongs to different species, then, despite the generally accepted view, most of the interspecific hybrids thus obtained gradually become quite capable of producing germinable seeds during the few years subsequent to the onset of, if not in the very first years of, their fruiting.

Most fruit-plant species have races or varieties characterized by some parts of the plants being more or less red in colour.

On crossing such a variety to a plant with leaves, shoots and buds of the usual simple green colour and with white flowers, throughout the entire period of development beginning from the cotyledon stage the degree of blending of parental characters will be clearly indicated by the intensity of colour of every part of the hybrid seedling derived from such a cross.

On the basis of my own work, I would recommend to use for these exemplary hybridizations the following pairs: of the apples, *Malus Niedzwetzkyana* is good as the male component, and as the female component the following cultivated varieties might be indicated: Anis and its variants, Korichnoye, Kandil Sinap, Chelebi, Chelebi-Kitaika and, especially, Bellefleur-Kitaika and Skrizhapel and its variants. Among pears the best male parent would be Krasnoplodnaya Burakovka; the female parents that may be used in crosses with that male parent are: Tonkovetka, Limonka, Malikovka, Russkaya Moldavka, Bergamotte Zelyony, Pobeda. Among plums I recommend as the male parent *Prunus Pissardii Koehne*, a variety with red leaves; as the

female parent: Ochakovskaya, Nikolskaya Belaya, Chernosliv Kozlovsky, Green Reine Claude and the hardy Japanese plum Botan. Among peaches the male parent recommended is *Persica foliis atropurpurea Zab.*, a variety with red leaves. Any of the common cultivated varieties might be taken as the female parent. Among nuts the red-leafed *Corylus avellana atropurpureis K.* and the common hazelnut may be used.

As for sour cherries, no red-leafed varieties of this species or of any closely-related species are as yet available in our country, so that, instead, for a sharper contrast in the structure of shoots and the shape of the leaf blade various races of sweet cherries have to be used as the male parent in crosses with the different varieties of sour cherries.

If the plants to be used as parents are not available and the crossings cannot be made, seeds should be obtained from red-leafed plant varieties that originated from natural cross-pollinations in their native localities. The experiments should then be confined only to planting the seeds and to making observations on the development of the seedlings from the very first days of germination.

It should be pointed out that when choosing the maternal parent preference should be given in general to those varieties from which seedlings are obtained that in their constitution deviate towards cultivated forms, i.e., even if they are not perfectly constant—which is actually never observed in seedlings of cultivated varieties—such should be chosen that at least do not give rise to specimens of rough and wild habit. It is with this in mind that I iterated the above-mentioned varieties as the more suitable for the role of progenitors.

The urgent necessity for such practical model experiments is quite obvious nowadays from the use that they bring, particularly in educating and training new young specialists for socialist horticulture, familiar with the practical methods of producing new and improved varieties of fruit and small-fruit plants.

CHAPTER 7

DETAILS OF CROSSING AND SUBSEQUENT CARE OF HYBRIDS

I now proceed to set forth in full the details of the work according to the second and the third methods (see Chapter 3).[1]

And so, in order to produce new, better quality varieties of fruit plants, we must cross our hardy old varieties of fruit plants with the best foreign ones. For this it is of course necessary to obtain beforehand plants of these varieties, and, where wintering sheds specially built for planting these varieties with a view to protecting them from the winter frosts are not available, each plant has to be put in a separate wooden box, which should be forty centimetres high and as much across at the top and thirty centimetres at the base. Three round holes, two centimetres in diameter each, should be made in the

[1] See "Principles and Methods," Ch. 3 (p. 188 in this volume).—*Ed.*

bottom for draining superfluous water. Over the bottom of the box it is first necessary to spread a drainage layer two centimetres thick made up of brick rubble and covered with coarse sand. Only then the box should be filled with earth consisting of one part of completely decayed manure two or three years old, two parts of not very fine sand and three parts of black soil. Into this mixture the sapling is planted after the ends of its roots have been pinched with a sharp knife and all of them have been dipped in a thick solution of clay.

The box with the sapling in it is placed at first somewhere in the shade, near the wall of some structure or near a fence, and should be well watered with river or rain water. The box must not be moved about or shifted to another place soon after the watering; otherwise the shaking may cause the still moist earth to settle markedly and become compressed, and this is sure to have a very harmful effect on the plant. Saplings should be obtained preferably grafted on low-growing stocks: apples on Paradise or Doucin stocks, pears on quince, plums and apricots on blackthorn, cherries on Mahaleb.

It is much better, however, if all the plants, both those which are to serve as female and those which are to serve as male producers, are not grafts but own-rooted—obtained by layering. For the easier rooting of layers of cultivated varieties of our fruit plants I have now elaborated a special method quite accessible to all, a description of which is given below. That it is of much greater benefit in hybridization to use plants having their own roots rather than grafted plants is a fact which has become obvious to me as the result of observations and numerous experiments. One glance at rows of hybrids from progenitors having their own roots and hybrids from those grafted on stock (from wild varieties) standing next to each other, will convince anybody once and for all that the structure of the former is far superior to that of the latter.

This fully proves that the root system is most closely involved in the building up of the seed.

When it is impossible to obtain ready plants of the best foreign varieties for crossbreeding, or if it is not desired to waste several extra years for their layers to grow, all that can be done is to order from southern fruit farms the pollen of such varieties, and the orders should be placed in good time, towards the end of the winter. If it is sent by mail before the local varieties begin to flower, it is necessary to bear in mind that, when preserved in a dry state, the pollen in any event retains its fertilizing capacity for a month. It should be noted here once again that for greater success it will be of much advantage to replace even our hardy varieties of fruit plants with varieties from colder northern localities: the two parent plants will thereby be placed in new environmental conditions, conditions to which neither of them is accustomed, and this will prevent the dominance in the hybrids of the characters of our local varieties by virtue of the fact that the conditions in our localities, which are their native habitat, are more favourable and habitual to them. This circumstance is of considerable importance for the flavour of

the hybrid fruits, their size and the prolongation of the period of ripening in winter storage.

Let us now examine the process of crossing in all its details. After choosing, on the basis of the conditions for better mating already explained, pairs of parent plants for crossing and after ascertaining which flowers on the maternal plants are best suited on account of their location, it is necessary to open the buds which are ready for blossoming the next day and, using tweezers or scissors, carefully castrate them, removing all stamens with the pollen sacs. Then, in order to prevent undesirable pollen from other plants being carried over by the wind or by insects, all such castrated flowers are to be covered with little bags of white gauze or some other white transparent stuff.

One or two days before the castration, pollen sacs of the male parent plant are collected from the flowers already beginning to blossom, in a small glass jar, which is then covered with gauze and put away in a dry place. The work of cross-fertilization begins on the day following the castration of the flowers of the maternal plant, the best time being the morning hours (from eight to twelve). The jar with the collected pollen should be slightly shaken and the pollen which has settled on the walls of the jar should be gathered simply with the end of a finger or, best of all, with the end of a thin plate cut from soft cork or rubber, and applied to the stigma of the pistils of the maternal plant. The flower thus pollinated is then again carefully covered with a little gauze bag. Such pollination should be repeated in the course of the next three days. In dealing with interspecific crossings definitely known to be difficult, I have often achieved success by adding a very small amount of pollen from the maternal parent to the pollen of the male parent. This, in my opinion, has helped better to stimulate the stigmas of the pistils, particularly if the stigma is of a somewhat compound structure, and not simple, as in the case of stone-fruit plants. When the mentioned method is employed there forms on the stigmas a substance peculiar to each species of plant, which helps the pollen grain to germinate. Further, in the 'nineties I made use of the influence of discharges of statical electricity upon the pollen, but the cause of success could hardly be attributed to the action of the electricity alone, which in these experiments was inseparably connected with the inevitable ozonization of the pollen.

The pollen was also subjected to the action of weak inductive currents of electricity. Lastly, it was placed for a brief period of time in the interpolar space of powerful magnets. I shall not set forth here the results of such experiments or what deductions are to be drawn from them, in view of the fact that they have not been completed.

Such experiments, if they are to be conclusive, require all one's time—a condition which I could not meet. Here I have made brief mention of them only to point out to my followers the possibility of applying them in hybridization.

But to go on. The fertilized flowers, covered with gauze, and supplied with a cardboard tag bearing the number and name of the variety of the male par-

ent, are left in this state until the fruit is fully matured, to prevent them from being injured by any insects. On the maternal plant it is necessary to remove superfluous flowers and as far as possible to prevent the shading of the fertilized flowers. Besides, care should be taken to ensure the general well-being of the maternal plant by the usual methods, excluding only such measures as may prove unsuited for the aims pursued because they hinder the development of the desired qualities of the new variety, as stated above. After the mature fruit has been plucked it should be left lying for at least a week in the case of early varieties (summer-ripening) and for several months in the case of fruits which remain fresh in the winter. After this, in the case of drupe cultures the stones are immediately planted in beds; in the case of pomes which mature in the summer, however, the seed, after being dried for two or three days, are stored in sand until they can be planted in the autumn directly in beds. In the case of varieties which mature and remain fresh in the winter, the seed are collected only when the fruits begin to spoil, but not later than in April, and are immediately sown in boxes prepared beforehand. When the seed are sown in boxes the varieties are separated from one another by glass partitions, and zinc tags bearing the name of the variety are placed in each compartment.

The box is then protected from mice by a wire netting fastened to its edges, and is covered with a layer of snow five centimetres thick. The melting of the snow at room temperature serves as the first watering.

After this, the box with the planted seeds is carried into the garden and buried in the snow dug down to the soil, where it remains until the spring.

Hybrid seedlings, if there were delicate foreign varieties among their progenitors, should in our localities be reared on meagre sandy soil easily permeable to water, so as to prevent the development of luxuriant growth with a crumbly structure of the woody tissue and a too protracted vegetative period of growth, as mentioned above. And yet it is necessary by timely pinching off of shoots at the end of each summer to check further growth of individuals that are late in terminating their growth. When pricking out the young growth after the formation of the third leaf, above the cotyledons, when transplanting the one-year-old plants, and, lastly, during the final planting out at the age of three years, the plants are provided different areas: 400 sq. cm. for each individual at the time of pricking out; 2,500 sq. cm. for each one-year-old; and, approximately, from 2 to 4 sq. m. for each three-year-old, where they remain until they begin to bear fruit. All species of drupes (apricots, peaches, cherries and plums), when being pricked out, are planted with larger intervals between them than in the case of pomes, because they suffer greatly when transplanted before they have borne their first fruit and, gradually deviating in structure towards that of wild species, they lose most of their good qualities.

They may, when absolutely necessary, be transplanted—and that with great caution—in the spring, and only at a later age. But in the case of particularly valuable hybrids of drupe cultures it is best not to transplant them

at all, but wait until they have borne fruit for two years and only then propagate the best strains by engrafting on suitable stocks.

In order to graft a new variety of sour or sweet cherry for the first time, it is better in all respects to start by getting a supply of seedlings of white sweet cherry, even if of a wild variety.

I insist on white because if a sour cherry hybrid with fruit of a white colouring is obtained, such a hybrid, grafted on the stock of white sweet cherry seedlings, will not change the colouring of its fruits.

I have found the influence of the stock most strongly pronounced in the case of the new variety Krasa Severa, whose fruits on the maternal seed tree were a pure white, but when propagated by grafting on the seedlings of the common red sour cherry, the fruits on the grafted trees were of a pink colouring. Here it should also be noted that new hybrid varieties of drupes in general and cherries in particular, when first budded, yield a very small percentage of buddings that have joined, and only when grafted in the second year with cuttings from individuals that joined in the previous year, the budding is more successful. In the subsequent years the percentage of buddings that join gradually reaches the normal.

The same is observed also in pomes, only in a less pronounced form.

We find an analogous phenomenon in the propagation of fruit plants by layers and cuttings.

Here too the first cuttings and layers of the new variety take root with incomparably greater difficulty than cuttings obtained from a specimen already layered or grafted; those obtained from the latter, rooted, specimens develop roots much more easily and quickly.

Even among currant hybrids we find varieties whose first cuttings require a hotbed for rooting, whereas the subsequent cuttings take root even when planted in the autumn directly in the ground.

We see from all this that only gradually does each plant become accustomed to the various operations performed on it by man.

I further repeat that, since recent experiments have fully corroborated that the completeness of hereditary transmission of the best characters of foreign varieties to hybrids largely depends on the influence of external factors, it is necessary under our climatic conditions as far as possible to eliminate or at least partially to mitigate the influence of harmful and to promote the action of useful external factors. Since it is known, for example, that strong winds have a very harmful effect upon hybrids when they are young—in the first three or four years of their life—because they hinder the work of the leaf system—the seedling beds should be placed, as far as possible, where they are most protected from the winds, overdrying should be avoided, the soil hoed in proper time, and the weeds removed.

The best and fullest possible development of the structure of each plant organism depends entirely on the work of the leaf system. The larger the number of leaves and the more complete their development, the better does the building up of the other parts of the plant proceed. It is therefore necessary to take good care to protect the entire leaf system from various pests by

administering timely sprayings with specially compounded chemical solutions (fungicides) against scab, rust and other diseases caused by parasitical fungi.

I recommend as the best compound for such sprayings: 100 grams of blue vitriol ($CuSO_4$), 100 grams of quicklime (CAO) and 10 grams of treacle to a vedro of water. Against gooseberry mildew (*Sphaerotheca*) I recommend a solution of 60 grams of liver of sulphur, which is a mixture of potassium polysulphide and thiosulphate (there is no definite formula), or from 30 to 60 grams of soda (Na_2CO_3) to one vedro of water.

Spraying with insecticides should be applied against insect pests which attack the leaves. To destroy various aphids, scale insects, etc., I regard as most convenient the washing of the leaves with a broth of 150 grams of quassia in one-fourth of a vedro of water, to which there should be added, after cooling, 100 grams of green soap, 10 grams of treacle and another three-fourths of a vedro of water. The spraying should be administered towards the end of the day.

In general, it is necessary to exercise great caution in applying solutions for spraying young, one-year-old hybrids. Weaker solutions should then be employed.

Otherwise, wrongly compounded solutions may often injure the plants, which in this case is of particularly great importance. For example, tobacco dust or a broth of tobacco are sometimes used to protect plants against aphids; but under no circumstances should young, one-year-old seedlings of plants, especially of drupes, be subjected to this treatment.

One-year-old cherries perish completely as the result of such treatment.

If these conditions are observed the characters of the best foreign varieties have a chance to develop more fully in the hybrids. Otherwise, even when they are transmitted to the hybrids, they will, in the absence of conditions favourable to their development, remain in a latent (recessive) state.

CHAPTER 8

CARE OF HYBRID SEEDLINGS: SOME SPECIAL METHODS

1. Hybrid seedlings must be prevented from developing a large number of small twigs by pinching off the side branchings in order to direct the flow of sap to the growth shoots. It is particularly necessary to perform this operation on drupe cultures, which in the early stages of their development are very prone to deviate towards a wild form with small branchings in the aerial parts, with the result that their fruits are of small size.

2. The first application of manure to seedlings should be made, as pointed out above, only when the plant begins to form its fruiting organs. The provision of extra nourishment should be continued in the course of the first three to five years of its fruit bearing, because during this period the

young hybrid seedling establishes the form and quality of its fruit, after which, in the succeeding years, the entire structure of its organism remains unchanged.

3. Even the neighbourhood of other varieties of the same species of plants during this period exercises, through their fertilizing pollen, a very great influence upon the form and quality of the fruit of the new variety, altering them in their own direction. If this influence continues for several years in succession, the alteration is fixed and becomes stable in the new variety.

This phenomenon is strikingly in evidence also among old varieties of fruit plants—for example, in the apple trees Bessemyanka, Antonovka and even our traditional Grushovka, and, of my varieties, in the Paradox. Here lie most of the causes owing to which the fruits of one and the same variety, but from different orchards in the same locality, are of different merit and even priced differently in the market. The influence of cross-pollination with neighbouring trees of other varieties, coupled with the action of a whole complex of local climatic and soil conditions, sometimes changes the qualities of the fruit of even our old, long familiar varieties of fruit plants to such an extent that fruit growers erroneously give new names to such strains, which results in a great deal of confusion. It is reckoned, for example, that as many as twenty-six strains of Antonovka apples are to be found in our orchards, although actually there exist hardly five strains, which have been produced by the planting of Antonovka seeds in various localities. Among the others we find either strains which have nothing in common with the Antonovka, for example, the Antonovka-Kamenichka, placed in the market by the Janichen nursery, and the Antonovka Zolotoy Monakh put in the market by Kleinmichel's nursery, or strains representing the ordinary Antonovka only temporarily modified by the influence of special environment conditions. In the orchards in the environs of the town of Belyov, for example, there is an ordinary Antonovka whose fruit retain their freshness until the spring, although as a rule the Antonovka becomes mealy and begins to spoil already in January. Another example: in the reproduction department of our breeding and genetics experiment station, in the old orchard, we have an Antonovka with fruit of a particularly dark-green colouring, which is apparently due to the action of the pollen of a number of neighbouring Arabka trees.

Nevertheless, the qualitative vegetative deviations are lost after transplantation to localities with other conditions, and the fruits become those of the ordinary Antonovka, as an old variety with stable properties.

In young hybrid varieties, on the other hand, and in the first years of their fruit bearing, such alterations may become fixed and remain forever in the new strain. All this must be borne in mind when training young hybrid seedlings. It is necessary, as far as possible, to eliminate undesirable or, in general, harmful influences of the environment and promote the influence of useful factors in the first three years after the saplings of the new varieties begin to bear fruit and until they attain complete stability in their structure.

CHAPTER 9

THE MENTOR METHOD AND THE VALUE OF GROWTH PROMOTERS

It not infrequently happens that hybrid seedlings, particularly if produced by crossing flowers from trees grafted on wild stocks or on stocks of a different species from themselves (apple on Paradise, pear on quince, etc.), have poor root systems incapable of sufficiently nourishing the aerial parts of the plant. This makes itself apparent in shoots too thin and leaf blades too small for the general form of the plant. In such cases, by way of replacing the inadequate root system, I use as "mentor" a well-grown two-year-old stock—the seedling of some cultivated variety with suitable properties; into it I bud the best eyes of the hybrid seedling, or else graft a cutting from the seedling onto its bark. Among apples I find Skrizhapel seedlings the stock best suited to the role of mentor; among pears, seedlings of Tonkovetka; among plums, seedlings of Ochakovskaya; and among cherries, seedlings of the wild white sweet cherry. Although as the result of such a graft the young hybrid seedling does change under the influence of the stock, this change is preferable to that which might occur if it were left on its own inadequate roots.

If a hybrid seedling is insufficiently hardy, it must be subjected anew to the influence of that of its parents which acted in the cross as transmitter of frost resistance. To accomplish this, cuttings of the seedling are grafted temporarily, for some two or three years, onto the crown of this parent, which serves in such cases as the necessary mentor for inducing greater hardiness. This is what was done in the case of the new Kandil-Kitaika variety of apple.

If the fruiting of a hybrid seedling is abnormally delayed, it often helps to graft onto its crown, by way of an inducing mentor, fruit-bud-bearing cuttings of some abundantly-yielding variety. Among apples one may take as such a mentor Slavyanka, Tayozhnoye, Anis, etc.; among pears, Tsarskaya, Bergamotte, etc. Such grafts remain on the tree only temporarily, for some two years, after which they are cut out. Such artificial forcing of fruit bearing succeeds only in the case of older hybrids, of over ten years of age, not in the case of young seedlings.

Here I must warn many people against the mistaken fashion of grafting hybrid seedlings onto the crowns of adult fruit trees in hopes of hastening the onset of fruiting in the new seed-grown variety. First of all, as I have said, this works only if you graft old varieties that have long borne fruit, and not young, not yet bearing hybrid seedlings; the onset of fruiting in the latter, far from being hastened, is delayed by it. Moreover, as the result of such a graft the new seedling variety in most cases loses a large proportion of its best qualities and sometimes actually shows a strong tendency to run wild. That may be clearly perceived the year after the grafting if a shoot from the graft is compared with shoots of the own-rooted seedling. This

degeneration is occasioned, first of all, by the grafting process itself, by the young seedling undergoing an unaccustomed operation, with subsequent formation of a union between the cutting and the stock; all this is fraught with suffering, as it were, because essential vital functions of the plant are interrupted. Secondly, it is due to the potent influence of the stock, as an old variety possessing a great individual power of modifying the young organism of the seedling. This latter circumstance produces considerable complications in the hybrid's constitution, since included among its properties now are properties of the stock as well, so that the result is already a vegetative hybrid.

From what has been said, it would appear that all the methods usually employed to reduce the excessive length of time between germination and fruiting of hybrid seedlings fail to achieve their purpose. But this is a state of affairs that can hardly be accepted. Man's life-span is so short that, after growing to adult age and spending two or three decades more on a thorough study of the laws of plant life, he is barely able, in the second half of his lifetime, to rear two or at most three generations of seedlings to fruiting age along the lines he desires. And that is certainly not enough for control experiments which would clear up many problems and riddles in the breeding of new fruit varieties. Searching for a way to overcome this difficulty, I discovered in 1924 the following amazing results of treating sprouts of the Posrednik almond with a 0.02% (by weight) aqueous solution of potassium permanganate ($KMnO_4$), as a vigorous growth promoter for the seeds of certain species. The results surpassed all expectations. Here I must mention first of all that, in our soil, seedlings of this almond variety usually grow during the first year to a height of 50 cm., during the next five years they attain a stature of 180 cm., and only in the sixth year do they bear their first fruits. When treated as I said, however, four such seedlings grew in the first year to a height of 180 cm. and formed flower buds, while in the second year they flowered and bore fruit.

This astounding leap in development was effected by the chemical catalyzing agency of the manganese, which not only enormously hastened the growth of the almond plant, but made itself felt in the second year as well, affecting the stones of the ripened fruits: the stones opened while the fruits were still on the branches, and the seeds sprouted. A diminution was also to be observed in the size of the fruits and the leaf blades, probably in consequence of excessively rapid growth and insufficient absorption of nourishment from the soil.

And although treatment with this manganese solution produced no effect on seedlings of pomes (apple, pear, quince, mountain ash, etc.), yet this fact I have described gives full grounds for hoping that at no distant date we shall find suitable chemicals for hastening the growth of other fruit plants too.

I have also succeeded by the mentor method in partially obviating various undesirable qualities of the fruit during the early fruiting years of a new

variety. Here is an example. By crossing the first-rate American winter variety Yellow Bellefleur with our orchard Kitaika, I got a new variety with large fruit-size and splendid flavour, which I called Bellefleur-Kitaika. Its first fruits ripened in the latter part of August and kept only until mid-September. Such early ripening was, of course, highly undesirable and needed to be remedied. To do this, I used as a mentor the renewed influence of the maternal variety. Some cuttings of the American Bellefleur were grafted in the crown of a tree of the new hybrid type. And beginning with the very next fruiting, the time of ripening receded gradually to a later date, until finally the fruits kept in winter storage until January.

Mentor action in transmitting colouring pigment has been revealed in a case I have cited before—the case of propagating by grafts the new cherry variety called Krasa Severa, which got its pigmentation from being grafted onto seedlings of the red cherry. But it is not every hybrid variety that is receptive to such transmission of colouring pigment. As an example of that we have a case when two green-leafed apple hybrids were grafted onto the same red-leafed Niedzwetzkyana stock: the fruits of one took on the colouring, but those of the other showed no trace of it. The mentor method described above had a beneficial influence in many different ways in the case of a hybrid of the bird cherry and sour cherry.

A refining influence was exerted by the mentor in the grafting of a hybrid seedling of the Beurré Easter pear. This was a ten-year-old tree which, while satisfactory in all other respects, had large numbers of long prickles and was very slow in growing. When slips from this hybrid were whipgrafted into the crown of a five-year-old grafted sapling of the Michurin Beurré Zimnaya, half of the vigorous limbs put forth by these slips were entirely without prickles, while the other half did have them, if only a few. It has thus become possible to propagate the new variety from the better, prickleless shoots only.

Of course, it is not all its characters that a mentor imparts; in most cases it is only individual ones among them. For example, on one occasion, when the Posrednik almond was grafted on a particular variety of plum, we got luxuriantly-developing shoots, but the union of these almond shoots with the plum was so precarious that at the end of the summer each shoot separated easily from the stock. When, the same summer, we took eyes from these vigorous almond shoots and budded them into the plum, the shoots resulting from this the following year were not of particularly luxuriant growth; but, on the other hand, the union was complete. Here we see the plum stock exerting its influence through first-year buddings on second-year grafts.

And, lastly, a profoundly interesting and highly valuable experiment has been carried out in our nursery by my immediate assistant, P. N. Yakovlev. In this experiment, lemons have been grafted as mentors onto a pear, one on June 5 and the other on October 25, 1926. Here we have an opportunity to observe the influence exercised on each other by two plants belonging not only to totally different species and genera, but even to two different tribes—in the one case, one-year-old seedlings of the lemon, an evergreen subtropical plant (*Citrus Limonium Risso*) from Central Asia, in the other, a one-year-old

hybrid seedling of the Michurin Beurré Zimnaya pear. It was probably only because they were so young and were taken out of their accustomed environmental conditions that the two could lend themselves to such symbiosis. The lemon, being an evergreen plant, naturally did not shed its leaves with the coming of winter; nay more, at quite an early stage it correlatively, through its influence upon the root system of the stock, prevented the pear too from halting in its growth and losing its leaves, although next to it, in the same room, similar hybrid pear seedlings potted out at the same time discarded their foliage at the usual season.

I need hardly say that we have no intention of growing lemons grafted on pears; we only want by this experiment to see and study the vegetative influence exercised on each other's constitution by two plants essentially so far apart.

For further and more comprehensive observation, we are leaving pear and lemon to grow side by side. After two years, we layered the ends of pear and lemon shoots, respectively, upon roots of their own, and are now rearing them, as also the original specimen, to fruiting age. Time will show what will come of this symbiosis. For the present we may hope that the lemon will communicate to the pear its fragrance and better winter keeping qualities, and will for its own part acquire greater hardiness for low temperatures.

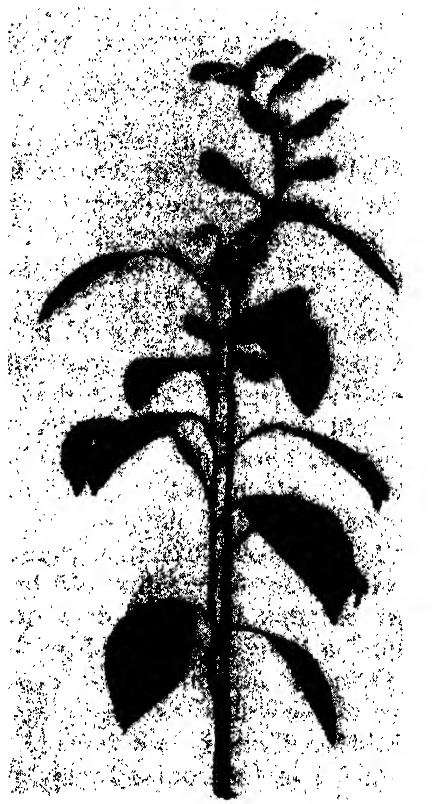


Fig. 38. A six-month-old lemon graft on pear (the larger leaves are the lemon)

Of course, as in all experiments, so in the use of mentors, complete failures also occur. A hybrid of Antonovka and White Winter Calville produced fruits of medium size and good flavour, but so ill attached to the tree that year after year a slight breeze was enough to blow the lot of them to the ground when they had only reached half their normal size. And though I used various mentors to cure this greatly intensified fault of White Winter Calville, it still persisted, and this hybrid had to be given up.

Instances of adverse mentor influence have also been known. This was the case, for example, when some cuttings of the Malikovka or Moldavskaya Krasnaya pear were furnished as mentor to an adult of the new Bergamotte Novik pear, in order to increase the latter's yield. Here the results of mentor action were of a somewhat unexpected kind. While the Novik yield did

increase greatly, the fruit-size diminished by half and ripening was delayed by half a month. As for the mentor itself—the limbs of the Moldavskaya Krasnaya scions—in the first fruiting years they bore fruits twice the usual size, but afterwards this feature gradually disappeared. So in this case the mentor did nothing but harm.

CHAPTER 10

ACTION OF MENTORS AND THE CONCEPT OF "XENIA"

First of all let us examine the doubts entertained by some horticulturists as to the possibility of what is known as "mentor" action. These, in effect, naive doubts are the direct outcome of insufficient practical knowledge on the part of many theoreticians. First of all, these people forget about the long and generally recognized influence of the stock upon the scion; secondly—and this is the chief thing in the present instance—they fail even now to realize that in young hybrid plants in the early stage of their development the faculty of changing constitutionally under various environmental influences is so much stronger than in firmly-stabilized old, long-standing species and varieties, that to judge of the change of the former by the latter is absolutely impossible. It would be laughable, you will agree, to compare the extent to which a child's organism reacts to its environment with the reaction of an adult or old organism. A blade of grass bends in the lightest breeze, while on a grown tree that breeze makes no impression whatever.

And if in propagating old fruit varieties we are compelled to recognize, after all, that the stock does undoubtedly influence the constitution of the scion—a thing now proved by thousands of examples—then, by sheer force of logic and common sense, even without any experimental verification, we have to recognize the ten times greater force of this influence upon young hybrid seedlings whose constitution is only just being formed.

And I in the course of my practical work, observing numbers of these phenomena constantly over a period of many decades, could not help arriving at the conclusion that if a whole root system exerts maximum influence upon a comparatively small scion of an old stable variety, then, conversely, though in lesser degree, a young hybrid seedling must also be influenced by having a cutting of some stable old variety grafted upon it; particularly as here the lesser potency of influence is compensated by the young hybrid's considerably greater susceptibility as compared with old stable varieties. And so it proved in the course of practical experiment, though the latter also showed that the result is by no means always a success; it all depends on the individual constitutional properties of the pair of plant organisms joined together.

Now let us make a general survey of all the factors by virtue of which one species influences another when they are conjoined.

First of all let me note the long and generally known influence of the

dwarf Paradise, Doucin and quince stocks, which figure so often in our horticultural work in producing fruit trees trained for form. Here we see that, when grafted upon such stocks, our old, quite stable varieties alter many of their properties: the growth of the shoots is cut short, the fruits become larger and more highly coloured, the flavour of many varieties improves considerably, especially in the case of pears on a quince stock—and some of these changes are caused wholly by the influence of the stock, while others proceed from intensive culture.

Further, I have had occasion to see adult pear trees which had been grafted by accident upon an apple stock; the taste of the fruits changed quite considerably as a result.

Then, a discovery made in my nursery among a party of grafts of a single pear variety. Among these trees, which had already reached fruiting age, I found one whose fruit, while outwardly identical with the grafted variety, had flesh of so firm a texture as to be totally inedible. Suspecting this to be a chance sport variation of the bud grafted on this particular tree, I tested it by grafting a cutting from this tree onto the crown of another. But the limb that grew from the cutting bore fruit with good flesh, convincing me that my surmise had been mistaken. Clearly, the thing was due to exceptionally strong influence of the stock.

Lastly, when a young tree of a tender southern variety survives as a chance exception in our orchards in the north (such trees are falsely regarded as acclimatized), it does so simply because it had the good fortune to land on a stock with a peculiar capacity for increasing the hardiness of the southern variety. Proof of this is the fact that grafts grown from cuttings from such specimens turn out to lack hardiness.

I should remark here that both in this last example and in all that went before, all changes in the properties of old, long-standing varieties proved to be unstable and conditioned only by the influence of a particular kind of stock. When the varieties in question were transferred by grafting onto ordinary, usual stocks, all these changes vanished without a trace.

The picture is very different as regards the influence of a stock upon a young hybrid that has been grafted onto it. Here the one- or two-year-old hybrid seedling, whose constitution is only just being formed, succumbs in maximum degree to the influence of the stock, and all changes occurring in it are to be observed in subsequent hereditary transmission. In the years that follow, as the seedling develops to fruiting age, its receptivity to changes in its properties diminishes gradually, until by the time of complete maturity the hybrid tree attains maximum constitutional stability, equal to that of old, long-standing varieties.

In making a general study of all changes produced in plants by hybridization, one must also mention, of course, the earliest manifestations of such changes in the fruits and pericarps. For some reason, it is the general practice these days to describe outward changes in the fruits from crosses of two varieties as "secondary xenias," treating such changes as due to the influence of the male parent's pollen. Here I perceive much that is wrong. In the first

place, such changes may result from the influence either of the immediate or of distant progenitors of the variety that provides the pollen; and secondly, they depend to no little extent on the influence of environmental factors upon the formation of the hybrid embryo in its seed—that is fully proved by the fact that the types of xenia vary in different years, though the combination of crossed forms is the same.

Then, too, supposing one does accept numerical designations for different types of xenia, it would be more fitting to describe a change in the appearance and even in the internal structure of the pericarp as tertiary, not secondary xenia, considering that the real, essentially important change induced by hereditary transmission occurs not in the pericarp, nor even in the whole of the seed, but only in the structure of the embryonic radicle of the seed, and this is what should be called primary xenia; a change in the structure of the accessory parts of the seed—the future cotyledons—will be secondary xenia, and a change in the pericarp, already tertiary xenia. Now secondary and tertiary xenias, which fluctuate in form and depend to a great extent upon the influence of the environment, are actually of no significance whatever for practical work; and all efforts to study them, and still more so, disquisitions and hypotheses about their origin and sketches of their forms, are so much totally useless labour. Judge for yourselves. Every real horticulturist must have seen that not only do different changes result in the fruits obtained by crossing the same pair of varieties in different years, but that even when the crossing of the two varieties is effected simultaneously on several flowers of the same maternal plant, the resultant forms of xenia are not the same. So is there any purpose in making drawings of such infinitely varied phenomena, to describe which is simply laughable, not to say more? Yet many people pore over this futile occupation.

Thus it should be remembered once and for all that the change caused in the appearance of fruits by fertilization with alien pollen (which is known as secondary xenia) varies infinitely in most cases as regards both the shape and the colouring of the fruit, and exhibits no recurring regularity whatever. One year, or very seldom in two years, you get one form, while in succeeding years, crossing of the same pair of varieties produces a totally different form of both fruit and pericarp. It all depends entirely upon the conditions of the environment, that mighty factor operating throughout the universe, under the influence of which all forms of living organisms, with the human species at their head, have taken shape. And so it is pointless to found any conclusions on such inconstant phenomena. All attempts to reproduce on paper the forms of these infinitely diversified changes in the fruits are, in effect, a useless occupation which cannot be of any practical value at all.

But let us go further. Let us assume that the combination of parent plants for crossing was suitably chosen. We plant the resultant seeds. We get seedlings, and here we encounter an infinite diversity of constitutional form, determined by the hereditarily transmitted characters of the parent plants, and also, once again, by the environmental conditions prevailing at the particular

time. Still, the general degree in which each of the seedlings tends towards culture properties can be seen, and it enables one both to choose the best among them by its outward appearance and, if so wished, to employ mentors in order to accentuate the deviation in the desired direction.

That will be expedient if we see that the development of the aerial parts of some of the better seedlings is retarded by an inadequate root system. This is very often the case because of the hereditarily transmitted influence of the parent plants' wild stocks, particularly if these latter have long been propagated solely by layering, as for example quince, Paradise, etc., which in the role of the parent tree's stock mostly produce, in hereditary transmission, hybrid seedlings with very poor root systems.

Fig. 39. The result of fertilizing almond with apricot pollen (the fruit obtained had an almond seed with four kernels from which four plants developed)

Here the seedling must be given as mentor a stock with a well-nourishing, strongly-developed root system—in the case of apples, for example, extra well-developed seedlings of cultivated varieties, particularly Skrizhapel; in the case of pears, seedlings of Tonkovetka; in the case of plums, the cherry plum; in the case of cherries, the sweet cherry; in the case of roses, the Leucantha rose; and so on. The development of the hybrid can nearly always be considerably improved in this way. In general, by such provision of mentors we increase the number of choice hybrids by more than half.

In the same way, the vegetation period of the hybrid can be reduced or increased by supplying as stock a species with a shorter or longer vegetation period.

In addition, by this method we can sometimes change the hybrid's constitution so much as to obtain a totally new type of plant. This is done by inarching the hybrid seedling with another hybrid seedling of a different species or even a different genus.

Usually in such experiments, where different species and even different genera are joined together, we leave the stock its main shoot with part of the foliage, so that the substances elaborated by the leaves of the stock may help to work more considerable changes in the scion and also in order to nourish the stock's root system.

It is sometimes possible to induce such changes by supplying a mentor to an adult but not yet stabilized hybrid, which is done by grafting cuttings of

the mentor variety onto the main branches in its crown; but, of course, the results will not be as stable as in the case of younger hybrids.

Let me describe in this connection several particularly revealing instances of mentor influence in its various applications.

1. The largest-fruited hybrid cherry variety existing today is Krasa Severa, which I originated in 1884 by crossing Vladimirskaya Rannaya Rozovaya sour cherry with Winkler White Cherry. In its fourth year of growth and first year of fruiting, this hybrid produced very large early-ripening fruits of pure white colour. That same year, this variety was budded onto a whole block of seedlings of the common red cherry. Starting with the third year, the budded seedlings began to bear fruits of the same size, shape and flavour, but pink in colour and somewhat later ripening. Here we see, in the first place, the influence of the stock upon the scion, manifested in the appearance of colouring pigment in the fruits; and, secondly, an instance of the mistakenly early propagation of a young hybrid variety, which had not had time to fix its properties sufficiently, otherwise the stock would not have affected the colouring of the fruit, as it does not do when old sweet cherry varieties with white fruit are budded onto it.

2. In most cases when young hybrid seedlings are grafted onto the crowns of adults of wild species, or even of cultivated types, under the mistaken impression that the influence of the stock and its root system will hasten the fruiting of the new variety, the result is a marked deterioration in the qualities of the hybrid. This can readily be seen by comparing the various features of the hybrid seedling's appearance with the corresponding features of the branch that grows from the graft in the crown of the stock. What is more, this practice will not help at all to hasten the onset of fruiting, as it does when an old variety is grafted on in the same way. Here too, I repeat, it is excessively naive to expect the same results from grafting onto the crown of an adult tree a cutting taken from an old, long-standing variety and a cutting of a young hybrid seedling. In the latter case, the onset of fruiting, far from being hastened, is actually delayed.

3. Even at the time of the first fruiting, a young hybrid variety is often still so susceptible to external influences that its ripening period may change even from fertilization with alien pollen. When a hybrid seedling of the Malgorzhatka pear produced its first flowers in the spring of 1927, and some of these flowers were fertilized with pollen from Michurin Beurré Zimnaya, the fruits from this cross ripened two weeks later than those which set from selfing. Here the alien pollen acted as a mentor.

4. An adult tree of the Bergamotte Novik hybrid pear set fruit very scantily during its first three fruiting years; this fruit ripened early (at the end of July) and was similar to the Bergamotte in shape. After some cuttings of the Malikovka pear had been grafted as mentor onto the crown of this tree, it fruited abundantly the second year, but two weeks later than before, and the shape of the fruits changed beyond recognition.

In addition, the fruits on the mentor scions themselves were twice the usual Malikovka size.

5. Sometimes mentor influence has proved effective in inducing fruit bearing in already adult trees of hybrid varieties which had long failed to bear; to serve as mentors in these cases, cuttings of old varieties noted for generous yields were grafted onto the crown.

But we get just the opposite results if we act on the misconception that the onset of fruiting in a young hybrid seedling at an early stage of development can be hastened by grafting a cutting of it onto the crown of an adult, already bearing tree of some variety.

By doing that, we get exactly the opposite—instead of hastening the onset of fruiting, we delay it, except where this operation is performed not with a young hybrid variety, but with an adult one close to fruiting age. There, one can indeed secure fruits in the second or third year after the graft, just as when one makes the usual graft of any old cultivated variety. But judging by numerous experiments of this sort, this method in most cases impairs the quality of the hybrid. Whereas with old, long-standing varieties, that happens very seldom, and then only if the graft is made onto the crown of an adult of a wild species, when the whole leaf system of the wild specimen brings its influence to bear on the small limb developing from the graft.

6. Lastly, as the most striking instance of mentor influence, let me quote the following: in 1926 (as I have mentioned before) my immediate assistant, P. N. Yakovlev, potted out a one-year-old hybrid seedling of the Michurin Beurré Zimnaya pear and joined a one-year-old lemon seedling onto its stem by inarching. A complete union resulted, and the leaves of the pear seedling gradually changed their colour for a darker one, developed a glabrous surface, increased in thickness of the blades, and did not fall in the autumn in the usual way, but remained unwithered for all of five years. Similarly successful results were obtained when a two-year-old lemon seedling was inarched with a one-year-old seedling of the Severnaya quince. Here the leaf-work of the lemon mentor—an evergreen subtropical plant—fundamentally altered the usual functions of the leaf systems of the young hybrids of respectively pear and quince.

When, however, it was attempted to effect such inarching with grafts of old pear varieties, union between these distant genera failed to take place.

There is a similar difference in the results of experiments in approximating two different species by grafting, as a preliminary to crossing them. These experiments too succeed only with very young hybrid seedlings, in the first year after germination. With old varieties, they are always a complete failure.

In general, most hybrid varieties grafted successfully at an early age on stocks of another species—as, for example, pears on quince, mountain ash, hawthorn, apple, and sometimes on even more distant species—retain the ability to grow freely on such stocks; whereas old varieties in many cases cannot be made to do this—witness the aversion which some pear varieties display towards quince, etc., as stocks. It is this adaptability of young hybrid plants to external conditions that enables the hybridizer to alter their nature and shape it along the desired lines with the help of a mentor.

The various examples I have cited will, I hope, dispel the doubts and

various misconceptions on the part of botanists as to the possibility of using mentors. It should at last be realized that the gap between the fixed properties of old fruit varieties and the weakly developed, only just forming properties of a young hybrid seedling is too wide for the latter to be judged of by the former. There you have the whole secret and cause of misapprehension, especially on the part of people who are only capable of rejecting the arguments of others, and not of producing conclusive evidence to the contrary.

Those are the practical conclusions that provide the answer to the misapprehensions existing in many minds as to the possibility of using mentors to improve the qualities of fruit-tree seedlings.

CHAPTER 11

SELECTION OF HYBRID SEEDLINGS

In essence, I divide plant breeding into two sharply different kinds. The first is selection from the mass planting of a certain species or variety of plants of chance deviations expressed in the form of mutations, or such as result from natural crossing with other varieties. I regard this kind of plant breeding as the meanest kind of work an originator can undertake, for only an utter ignoramus can plant haphazardly tens of thousands of plants belonging to one variety and then pick two or three of the best specimens and destroy all the rest. What does man give the seeds of the plants to help them to acclimatize themselves? In all such operations he relies solely on chance, he hopes that among the seedlings there will accidentally appear one out of several thousand specimens that will be relatively more hardy.

This haphazard method of acclimatization is not only totally unscientific, but involves the state in heavy and scarcely productive expenditure of forces and funds for conducting the work on these lines.

Nature alters the structure of living organisms, adapting them to the conditions of their environment only very slowly, barely perceptibly, in the course of whole milleniums.

By means of artificial cross-pollination (hybridization), however, it is possible to produce in relatively short periods of time considerable changes in the hybrid plants which gradually acquire complete stability if this crossing is repeated for several years.

Consequently, man should proceed only along this more reliable road and resort to selection from simple mass planting only in extreme cases when the possibility of employing hybridization is completely absent. Nevertheless, the majority of our experimental stations base themselves in their work exclusively upon selection from simple mass planting and put this method in the forefront.

Such miserable treasure hunters base themselves solely on the material possibility of mass planting and later are satisfied with isolated, chance finds among these plantings. It is permissible to resort to these methods of selection

only as subsidiary work, when there is an extreme lack of experience in raising new varieties.

The originator must strive with the aid of hybridization and individual selection to prepare beforehand not a hundred thousand, but only some tens of seedlings with approximately the desired structure of organisms and then, by proper training, to improve the largest possible number of them and make them worthy of and useful to man. In all my work I pursue only this aim, and very rarely, in extreme cases, only in between other work, do I permit the seeking for luck. In magazines and various pamphlets certain

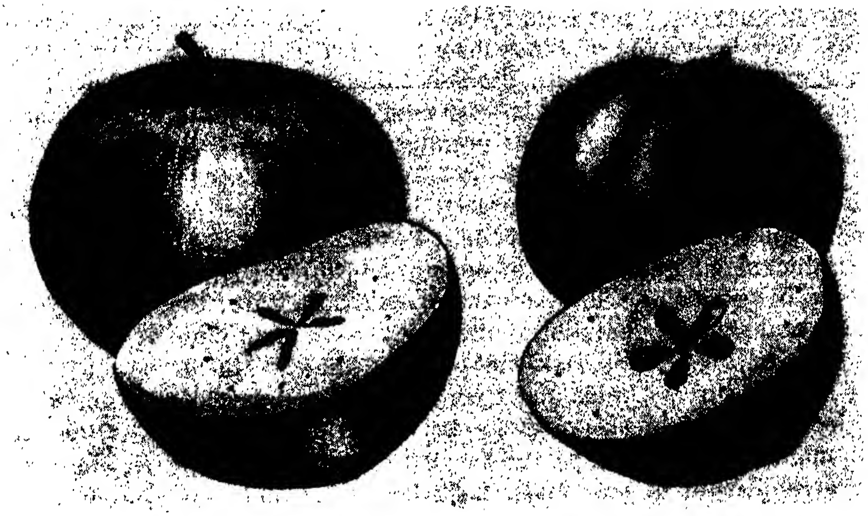


Fig. 40. The influence of alien pollen on the flesh: right—Michurin Bessemyanka pollinated by Oberdieck-Reinette, left—Michurin Bessemyanka pollinated naturally (control)

highly imaginative writers put my work in an extremely false light by placing it on a par with the work of the late Burbank, an advocate of planting many thousands.

Except for error at the beginning of my work, I have not based myself on mass planting and have never been carried away by silly treasure hunting, for I regard such work in horticulture as being, to say the least, of very little value and inevitable only on the introduction in our gardens of entirely new species of plants hitherto unseen in our localities, hybrids of which it is, as yet, impossible to have as, for example, the wild fig tree (*Ficus carica L.*), persimmon (*Diospyrus lotus L.*), wild lemon (*Citrus trifoliata*), etc.

But for such plantings I was unable in the past to procure seeds in any considerable quantity owing to lack of means; now, however, I receive, through government institutions, some of the seeds of this kind in sufficient quantities for planting for selection purposes when thousands and not tens of seeds are required.

Here it is necessary to explain how the process of selection itself should be carried out; what to select, and by what characters one must be guided in selecting, will be shown later.

The first selection should be made when the plant is still in the cotyledon state; relatively large cotyledons, their considerable thickness and short and thick stalk under them (*hypocotyl*), and tricotyledonous sprouts are the best signs of cultivation.

The colouring in various shades of the lower and particularly of the upper part of the cotyledon always infallibly indicates the future colouring of the fruit, and in flower plants, roses, for example, the colour of the flowers.

During the second selection, in the last month of the vegetative period of the first year before the seedlings drop their leaves, it is necessary to inspect them several times a day with the sun shining on them on different sides. This is necessary because only by means of such an all-round inspection is it possible more fully to note all the peculiarities of the habit of every seedling. Even a change in the direction of the wind sometimes sharply reveals one or another previously unnoticed character of the seedlings. At the first general glance at the seedlings the best are noted as regards stouter build, size of leaf blades, thickness and shortness of petioles and thicker shoot tips.

Then, in particular, the best signs of cultivation are: thicker leaf blades, rounded and shallow dentation of their edges, fine and close venation of the undersides of the leaves, dark, flat-coloured and wrinkled top sides, thick down (in apple trees), thick short petioles and well-developed stipules.

Selection after leaf dropping. Large, round buds at the tips of the shoots of the main stem, downy tips and faceted shape of their shoots, close steep-spiral arrangement of side buds, their large size and very prominent bud cushions are all general favourable signs and, in particular, a sign of a compact structure of the pulp of the future fruit; a sparse arrangement of buds in a wide spiral, however, presages a looser structure of pulp. Broadtipped buds, closely pressed to a straighter shoot is a good sign, whereas slender buds, deviating from a wavy shoot are signs of the wilding.

In stone-fruit plants, large round buds, arranged in groups of three and more, and large and numerous glandules on the petioles are good signs. In the majority of cases, a darker colouring of the bark of new shoots is a sign of late winter ripening of the future fruit, whereas a lighter colouring promises a summer ripening variety.

The absence of small prickles and general low growth are also good signs.

When selecting, it is useful to compare the shape of the shoots and leaves with those of their parents, and to take this or that similarity into consideration when appraising the merits of the seedling. Moreover, it must be borne in mind that all these signs in one-year hybrid seedlings are in most cases only in a rudimentary, sometimes in a barely perceptible state and gradually develop to their full dimensions only in subsequent years of the seedlings' growth.

Then again, the good merits of a seedling do not depend upon the absence of some of the signs enumerated above at any given time. Sometimes one of

the signs develops earlier, while others are noted only later, at the next selection at a higher age.

In some cases even the presence of one of the bad signs does not in the least prevent the seedling from being an excellent variety. For example: in the well-known old and valuable variety of pear, the Beurré d'Hardenpont,

Fig. 41. Leaves of hybrid seedlings of Bellefleur Yuzhny (upper centre—the best of them)

the leaf blades and their dentation are of such a coarse structure that they positively give the tree the appearance of a wilding, and yet the fruit of this variety, for its size and flavour, is first grade.

The same may be said about the Olivier de Serres pear which, with all its good qualities, has very small leaves and exceedingly feeble shoots.

The third selection is made according to the same signs in the autumn of the third year of growth, and in the following spring the selected seedlings are transplanted to their permanent locations (each seedling is given an area of two to four square metres) until the fourth and last selection for bearing, which is made according to the quality of the fruit of the third-fifth year of bearing, and the best of them, those which have fully passed the test for the stability of their characters, hardiness and yield, are propagated by the ordinary method of budding on young, two-year-old stock.

In some years, in the latter part of August, there is a long period of constant high atmospheric pressure (between 760 and 770 mm.). This, according

to my observations, greatly affects the organisms of perennial plants and forces some of them to bloom again in the autumn.

In such cases, certain varieties of apple, cherry, mountain ash, bird cherry, and others have a second budding.

In such years a second flow of sap is also observed in hybrid seedlings, and this causes the plants to suffer considerable damage from autumn frost, against which we cannot take any measures; but in selecting we must not reject such damaged hybrids as lacking hardiness.

In conclusion it is necessary to point out once again that the first three selections of hybrid seedlings can be performed only by one who has acquired practical skill in carefully noting the characters of plants. It is quite impossible to give a sufficiently full description of the characters and their various combinations.

The fourth selection, according to quality of fruit, can, of course, be performed by anybody who is in the least acquainted with varieties of fruiters.

Further, in all selections, it is necessary to watch particularly for the manifestation by the hybrid seedlings of any degree of immunity to various diseases in general, and to damage by fungi parasites and insects in particular. Such a quality in certain hybrids must be carefully noted and cherished in general. This is not only of enormous importance in cultivating the given varieties; in the future it will be possible to single out from their progeny a whole series of new varieties that will be staunch in the struggle against plant pests.

And such varieties will be of enormous value for the fruit-growing industry of the U.S.S.R.

CHAPTER 12

SOME SPECIFIC FEATURES OF OWN-ROOTED FRUIT PLANTS

It is wrong to assert, as many do, that in propagating plants from cuttings, the form or variety of the given plant remains unchanged. It is particularly wrong to say that about the propagation of our fruit trees from cuttings. Here it is necessary to bear in mind, first of all, the influence of the replacement of the root system of the cuttings taken from trees grafted on the stock of a wild species by their own roots, which inevitably affects the quality of the variety, although in a good way.

It follows, then, that the variety undergoes partial change. To this it must be added that here we may come across a sport deviation (bud variation) of one of the buds of a cutting (this, in general, happens rather rarely in old, long-existent varieties of plants, but in hybrids, particularly at a young age, up to ten years, sport deviations must be regarded as a common occurrence). Lastly, when raising hybrid seedlings we also inevitably come across a constant, regular and gradual change in the entire habit (external appearance) of the hybrid, beginning from the first year of its development from the seed

to the first five to ten years of bearing. All seeds of hybrid origin, when germinating, produce, as a consequence of atavism (a reversion to ancestral characters), all the parts of the aerial habit of a wild species, which, as the seedling develops, both in the first year of growth and in subsequent years until the plant reaches maturity, differentiates only gradually, undergoes a whole series of changes in form and finally assumes the structure of a cultivated species. Further, if an adult tree of a hybrid that is already beginning to bear is cut to the root neck, its offshoots will again have the appearance of a wilding, and in their subsequent development will go through all the changes that the seedling went through after germination from the seed. And yet, if an adult bearing tree grown from a cutting that was taken from the seedling is also cut to the root neck, the offshoots from the root neck will not have the structure of a wilding, but will at first have the form that the cutting had, and from this form will go through all the other forms until bearing time; however, a considerable deviation for the better is observed owing to the improved structure of a different root system, which is incapable of giving at first offshoots of a wild type. I performed these experiments as far back as the end of the 'eighties and repeated them in 1915, but only up to the second vegetative generation, i.e., I took the cutting from an already bearing hybrid seedling (a Reinette Bergamotte apple). It is my intention to repeat the experiments on subsequent vegetative generations, i.e., in the third generation to plant cuttings not from the seedling, but from the first tree raised from a cutting, etc. To make this clearer I give an illustration [Fig. 43] where *A* is a two-year-old seedling; *B* is a cutting of the second vegetative generation,[1] the root system of *B* is already improved and

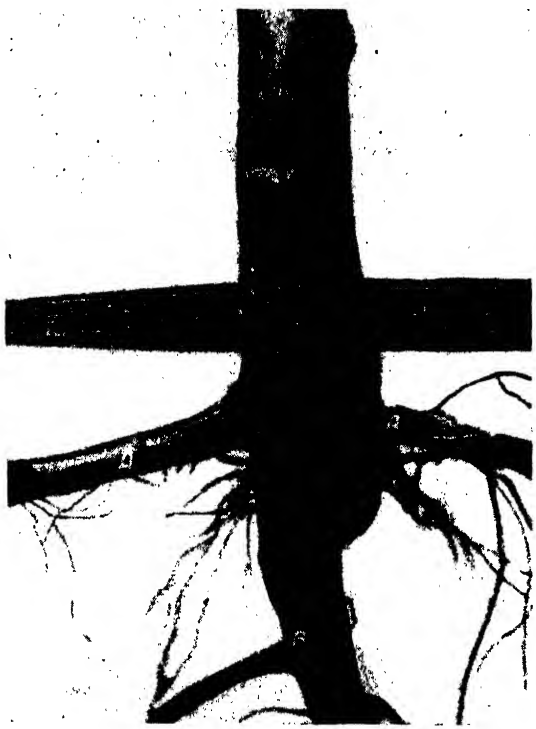


Fig. 42. Development of roots by pear (A) grafted on apple stock (B)

[1] Cuttings are up to 20 cm. in length from a single shoot or one with branches.

its root neck already gives offshoots of the structure of *B* and not of a wilding as in *A*; *C* is a plant raised from a cutting taken from *B* in the third year of growth. The root system of *C* is still further improved and gives offshoots shaped like *C*, and so forth (see dotted arrows).

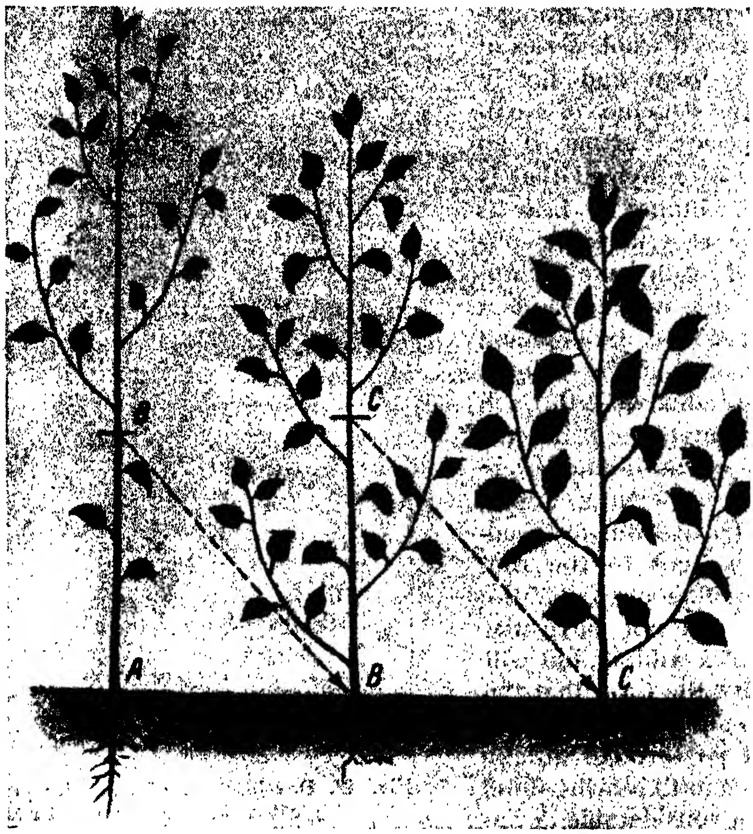


Fig. 43. *A*—two-year-old seedling; *B*—cutting from second vegetative generation; *C*—cutting from third vegetative generation

Then, after rooting by a method that I have devised, which even fruit growers of little experience can employ, the cuttings are planted in the bed when the leaves are fully developed. The cutting specimen bears fruit earlier than the seedling did. The cutting specimen of the second generation should bear fruit even still earlier, and so forth. This last assumption is now being tested on eighty varieties. In addition to all that has been said, it must be noted that only by repeating this rooting of cuttings in several vegetative generations is it fully possible to develop in the new variety of fruiters the ability to take root easily from a cutting simply planted in the bed.

CHAPTER 13

METHODS OF ROOTING CUTTINGS

My methods of rooting plant cuttings and planting them in the middle of the summer with fully-developed leaves, methods which I have employed with particular success in propagating and at the same time improving the qualities of new hybrid varieties of pears, are as follows. In the latter half of the spring, on the cutting *A* (see Fig. [44]) from a one- or two-year-old[1] shoot 20 cm. in length, which may be branched, a strip of bark *B* 5 to 8 mm.

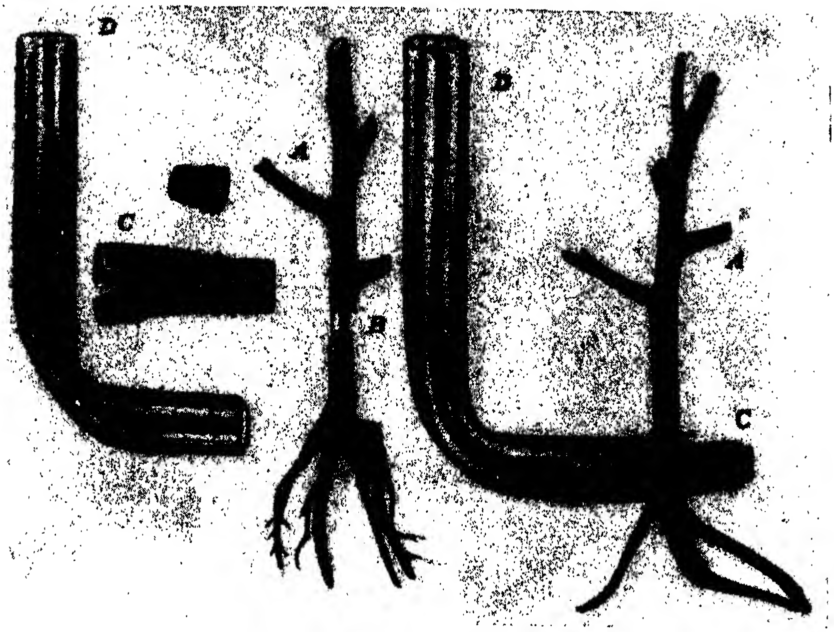


Fig 44. New apparatus—tube for rooting cuttings

wide is removed, and forthwith a rubber tube, *C*, prepared beforehand, is put over the bared part; the tube is 60 mm. long, outside diameter 12 mm., thickness of the walls 2 mm.; consequently, the internal diameter will be 10 mm. In the middle of this piece of tube two apertures[2] are bored through both walls with the aid of a sharp-pointed steel tube worked with a revolving motion; then, half the tube is slit from the tip to each of the apertures in the walls.

The tube prepared in this way is slipped on to the part of the cutting that has been bared of bark *B*. It closely grips the bark of the cutting on the lines above and below the bared ring. Both halves of the remaining parts of the incised rings are inserted in one of the ends of a glass tube *D* bent at right

[1] The younger the hybrid seedling, the easier it is to root; and on the contrary, cuttings from old trees take on with much more difficulty.

[2] The diameter is about 2 mm. less than the outside diameter of the given cutting near the place where the ring of bark is removed.

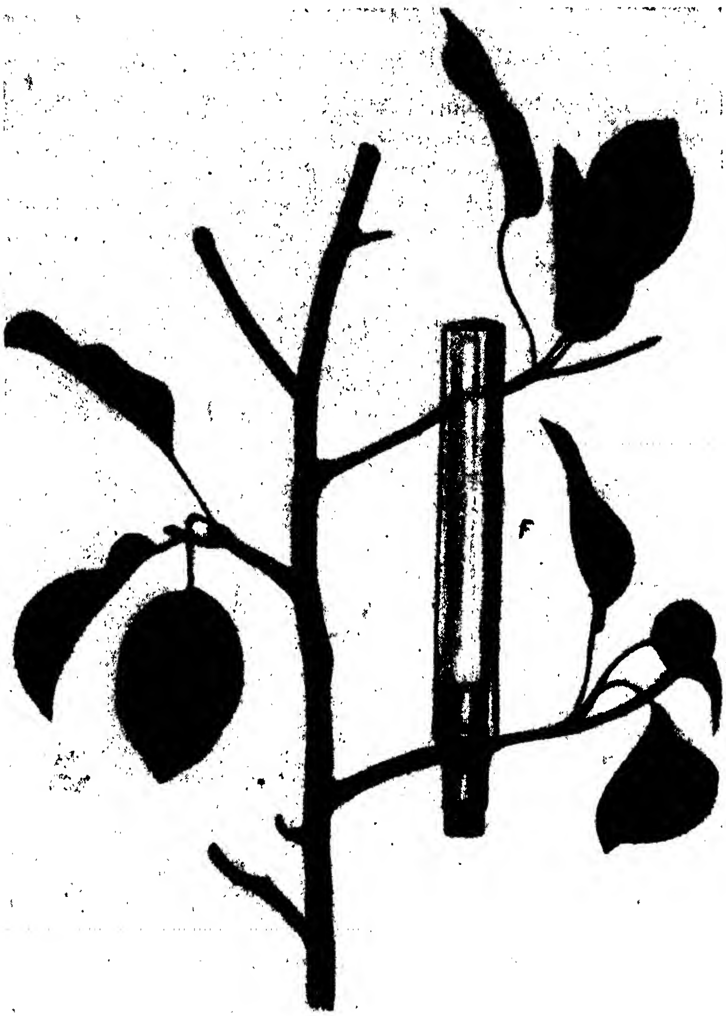


Fig. 45. Straight tube (F) for rooting cuttings

angles and having an internal diameter of 12 mm. If a bent glass tube is not available a straight piece F 10 cm. long, of the same diameter (see Fig. [45]) may be used.

Moreover, in order that the rubber shall grip the bark of the shoot more tightly, the tube is tied in crisscross fashion with thick cotton thread and smeared with liquid grafting wax; the other, slit end of the rubber tube is stopped up with a cork (see Fig. [46]). Then, into the open end of the glass tube, which is fixed in a vertical position, boiled water is poured; as the water in the tube evaporates, it must be replenished; and to prevent putrefaction the water must be changed every week, using cooled boiled water.

If this regime is adhered to for a period of five to seven weeks, according to the species and variety of plant, a callus will first appear in the gap

Fig. 46. Formation of roots in tube and thickening of cuttings above tube

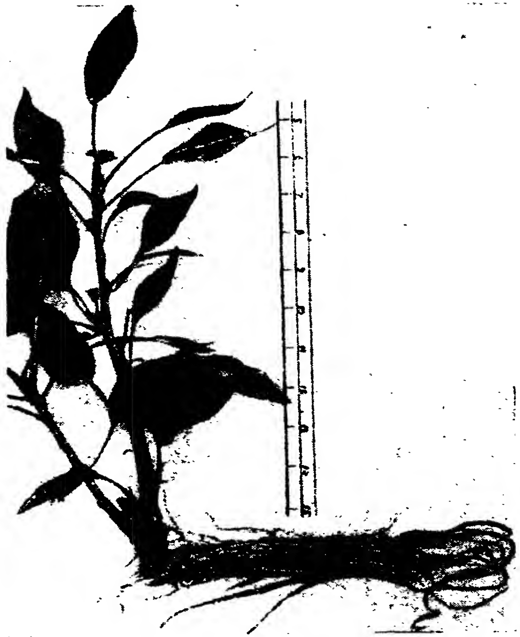


Fig. 47. Cutting of hybrid seedling of Olivier de Serres pears with roots formed in tube

Fig. 48. Detached cutting with roots formed in tube

of the rubber tube and then roots, and the shoot above the tube will thicken considerably thanks to the deposits of nutritive substances furnished by the leaf system and retarded in its downward movement by the removal of the strip of bark. This stock of nutritive material will sustain the life of the cutting during the first period after planting in the bed. As a consequence of this, notwithstanding the hot weather in July, the leaves of the cutting do not perish, and this is observed in the majority of pear varieties on which I am at present conducting the work referred to. As regards varieties of apple, with rare exceptions the whole process is limited to the formation of the callus, and cuttings with this callus, on being planted in the bed, lose their leaves and take root in the following summer. The cuttings are made and planted in beds five to seven weeks from the time the tubes were set, at one's own discretion. With cuttings from the second vegetative generation, i.e., when rooting cuttings not from seedlings but specimens previously rooted by cutting, the entire process of development of the roots takes place much more easily and quickly.

Evidently, the plant, in adapting itself to this operation, develops the ability to take root more easily. Some varieties of pears, for example, seedlings from the well-known Olivier de Serres (see Fig. [47]), manage to give in one summer two vegetative generations of rooting cuttings (see Fig. [48]). In this way, it is easy to root branches taken from the crown of an adult tree with fruit buds and have low fruit trees of the old varieties with their own roots.

This method of rooting, when it is fully worked out methodologically and technically, promises to cause a veritable revolution in the art of fruit growing in the future.

In the present case we will have to wait a much shorter period for the fruit trees to begin to bear than in the case of grafted trees. In conclusion I must say that by way of experiment I cut and planted in the bed several cuttings from a pear with one callus even before the roots developed. True, the leaves of the cuttings suffered somewhat when they were planted in the bed; nevertheless, the cuttings will probably stand the operation well and in the spring will begin to develop roots, and then, perhaps, it will be possible to dispense with the glass tube and water, and it will be only necessary to cover the ringed part of the cutting with the slit part of the rubber tube, which will be fixed tightly to the bark above and below the bare part by tying it with cotton thread and smearing the slit in the tube with liquid grafting wax.

The cutting is made and planted in the bed six to eight weeks after the cuttings tube is fixed to the shoot.

CHAPTER 14

DWARFING STOCKS AND THEIR SIGNIFICANCE

I now have freely growing, without any protection against the winter, a considerable number of southern species and varieties of fruiters—Reinettes, Calvilles, the winter varieties of pears known in the trade by the general name of Duchesse, grapes, apricots, almonds, quinces, cherries,

mulberries, walnuts and many new fruit and berry plants hitherto never before cultivated in our parts.

Lately, I have been working to put into cultivation in our orchards peaches, sweet almonds, chestnuts, persimmons, various species of actinidia, and others.

Furthermore, a beginning has been made in raising special dwarfing varieties of stock for trained apples, pears and, in particular, for the cultivation of squat types of apricots and peaches. The extreme need of low growth for the latter is now recognized by all fruit growers in the West and in North America. In our localities, with their relatively severe continental climate, the production of a dwarf peach with a short vegetative period is absolutely essential.

The point is that with the low-growing types of apricots, and particularly peaches, firstly, the plants always complete their growth (vegetation) earlier than the ordinary tall trees and their wood matures more fully; thus, the vegetative period they need is considerably shorter and their resistance to winter frost is greatly enhanced.

Secondly, it is easier to provide low-growing plants with some kind of artificial protection against the winter, and sometimes a covering of snow alone is sufficient to protect the fruit buds, which suffer from frost more than all the other parts.

It is necessary to obtain low growth, although for an altogether different reason, also in plums, and particularly in sour and sweet cherries; such a type of plant is imperatively called for by the inconveniences noted both in North America and in the U.S.S.R., in picking the fruit from tall trees and protecting them from birds.

As dwarfing stock for apples, I have so far found nothing better than the ordinary Paradise and Doucin. For low-growing pears, however, I have raised to replace the common quince, which is unstable in its resistance to the frost in our parts, a new, quite hardy variety which I have named the Severnaya quince, produced from the crossing of a wild quince from the Caucasian mountains with a quince from Sarepta in the Volga district. This new variety, which bears every year in my nursery, in addition to complete resistance to frost, possesses the quality of growing in dry locations, a quality which has become fixed and is transmitted by heredity to seedlings already of the third generation that I have. I have also selected pear seedlings of natural dwarf growth. For low-growing types of the tender varieties of plums and apricots, the stock from common seedlings of the low-growing sloe fully answers the purpose, but I think it is far from adequate for cultivating peaches in our parts. Here a much lower growth is needed, and for this reason I select from among the sloe seedlings specimens of exceptionally low growth, and later I will propagate them by the vegetative method—by layering. When selecting I take into consideration the relative stoutness, if one may so express it, of the development of the shoots, i. e., their thickness, which, in my opinion, serves to indicate the ability of the root system of the stock adequately to feed the peach grafted on to it. In the opposite case, i.e., if, when selecting, one

comes across a seedling, even of the dwarf species, but with very thin shoots, it is unsuitable for the role of stock. This also happened to the Siberian fruit grower Nikiforov. He found a dwarf variety of the Siberian crab apple which he named Pigmy. Its root system was so feebly developed that this stock was unable to feed the cultivated variety of apple grafted on it, and all the scions perished from shortage of nutriment. As regards raising stocks for cherries that would really give squat growth to the cultivated varieties grafted on to them, for the time being we must be satisfied with the American sand cherry (*Prunus Besseyi Waugh.*). Although at the present time it is one of the frost-hardiest and in many respects the best stock for cherries, the lowness of the cherry trees grafted on to it is actually inconsiderable. The hybrid I have raised by crossing a sweet cherry with the Ural low-growing pearlike sour cherry, which I have named Gnome, is, however, a splendid, low-growing cultivated variety of cherry, and is really irreproachable as a stock too. It is very short (not more than 50 cm. high when six years old) and has thick shoots (up to 6 mm. at the tips). This stock is quite hardy, although the pace at which it goes through all the phases of its development is extremely slow. Unfortunately, so far I have not succeeded in propagating it by the ordinary methods—by layering, or even by summer budding; evidently, exclusively spring budding with a living bud and subsequent propagation from cuttings will alone be suitable for this variety.

And in general, to obtain low-growing types of cherries, in addition to selecting stock that answer the given purpose, it is necessary to raise new varieties by requisite selection for yield and hardiness, and exclusively low-growing types.

Only then will their planting bring in a good revenue....

CHAPTER 15

BREEDING NEW FROST-RESISTANT PEACH VARIETIES

In the early period of my activity (back in the eighties of the past century) devoted to the improvement of fruit plants of superior-flavour qualities with a view to making them more hardy in our locality, I could not of course even dream of introducing in our orchard culture fruit plants so exacting in regard to warmth as apricots and peaches. All the more so since among our wild forest types there was not a single representative of these plant species, and, consequently, I could not in this case even think of hybridization, i. e., of crossing delicate cultivated strains with our wild species with the aim of obtaining more frost-resistant seedlings, just as I do with pears, apples, cherries and plums. The almond I obtained by crossing the dwarf almond (*Amygdalus nana L.*) with *Prunus Davidiana Franch.* (David's peach), which I named Posrednik, even though it does cross with cultivated peach varieties, produces for the most part seedlings entirely identical either with the maternal plant or with the paternal plant, and with hardiness insufficiently enhanced. Besides, all the attempts of horticulturists to introduce peach culture in localities north of the Crimea, even in places much more

to the south than our parts, for example, in Kiev or Chernigov, usually ended in complete failure.

But in spite of this I never gave up the idea of finding some means of overcoming all these obstacles. In the end, after further searches I obtained the stones of several hardy varieties of the Manchurian apricot and a semi-cultivated type of peach from middle Manchuria and, later, of another semi-cultivated type of peach from North Korea, which thrive in places even severer than our locality (as regards climatic conditions in the winter period, the absence of a snow cover throughout the first half of the winter and the temperature dropping to 33° below zero Centigrade). The only material difference is the longer summer period in their native regions, owing to the fact that their latitude is much lower south than that of our locality. Though, on the other hand, they are partly subject to fog and cloudiness (the number of sunny days there is greatly reduced), which almost equalizes the longer summer period in the home of the Korean peach with our relatively short summer. Nevertheless, in our locality the majority of first-generation seedlings (owing to the late germination of the stones) have shoots of summer growth insufficiently ripened and, naturally, their tips and sometimes the entire shoots suffer from the winter frosts and freeze down to the snow line. Such individuals, which suffered in the first winter, should be replanted without fail in the spring of the second year, their roots being shortened by one-third. Otherwise they will develop during the summer of the second year very luxuriant shoots replacing the destroyed parts and then they will again freeze in the second winter. The individuals which terminate their growth earlier have to be singled out. The specimens obtained cannot of course as yet represent quite suitable varieties for extensive peach culture on commercial lines in our parts, because the fruits will not have a good enough flavour and will ripen very late. Besides, the saplings of these varieties selected for hardiness will have the defect of early blossoming and, consequently, their flowers will often be destroyed by morning frosts in late spring. But all these defects can be eliminated by one of three methods or by a combination of these methods simultaneously applied.

Fig. 49. Dwarf nine-year-old blackthorn

The first and simplest method consists in planting large numbers of

stones from several generations of seedlings selected for relative hardiness and early maturation of fruits in our locality. The second method, which takes less time, consists in altering the constitution of the peach seedlings at the earliest stage of their development through the influence of the stock (vegetatively), for which purpose the seedling in the first half-year after its germination from the seed should be budded upon a stock of our local feebly-growing blackthorn. The third method is that of hybridization, of crossing the peach with the hardy dwarf almond or its hybrid, Posrednik. Lastly, a more reliable way is to combine the action of the second and the third methods. In this case, by shield budding with still not fully ripened buds from half-year-old peach seedlings upon blackthorn, we introduce considerable alterations into the constitution of the young and still unstable organism through the influence of the stock in the direction of reducing the vegetation period. This is observable even in the fact alone that the buds grafted upon blackthorn stocks complete their formation a full week earlier than the buds of seedlings grown on their own roots. From the very first year all such grafts develop a more squatty growth and complete it much earlier, as a result of which the woody tissue matures much more fully and, naturally, becomes more hardy to the winter frosts. Then, in the spring, the sap from the roots of the stock begins to move much later, with the result that the beginning of blossoming is retarded, and the fruits are thereby safeguarded from being injured by morning frosts in the spring. All such alterations provide in their sum the opportunity of obtaining quite sturdy and hardy forms close to cultivated peach varieties. [1]

At present the production in our parts of hardy hybrid varieties of peaches by means of hybridization with old varieties which yield large-sized fruits of superior flavour no longer offers any difficulties.

Mention should be made also of a special variety of dwarf blackthorn, two metres in height, suitable for this purpose, which I bred in the course of forty years by planting four generations, by training the seedlings and by strict selection of specimens for low growth and absence of root shoots.

As a result of all this the new variety is easily reconciled to the new plant community. In general, as regards phytocenosis (plant community) it is to be presumed that in the vegetable kingdom, with the exception of epiphytes, cenosis (community) plays an important role only in the beginning of the origin of each species. Later the effect of community presents no serious obstacles either for propagation or for the spreading of a species to a different locality; otherwise we would not be witnessing the diffusion of numerous identical species in various parts of the globe.

In this case, apparently, the plant should also more easily acquire the property of changing from a constitution characteristic of short-day plants to a type characteristic of plants adapted to the longer day in our locality, and photoperiodism will not present many difficulties in this respect.

[1] This approach towards acclimatization of exotic plants is, firstly, quite new and, secondly, fully serves the purpose.

Fig. 50. Korean peach

Of the numerous species and genera of stone plants, so far scarcely more than a dozen species have been introduced in our orchard culture; the rest still remain largely in a wild state in various parts of our vast Union.

In this review I shall only mention a small part of the new types I have introduced into culture with varying degrees of success. Yet if many of them had been subjected to the powerful action of hybridization and selection we should most likely have obtained numerous new varieties of good quality as regards productivity and effectiveness for culture in our orchards. Furthermore, in this sphere (introduction to culture of wild species of stone fruits) we come across utterly unexpected phenomena such as the fact that in the case of the universally-known delicate warmth-loving apricots and peaches which in our country are grown only in the southernmost sections of the Union (Crimea, Kazakhstan, the Caucasus), closely-related species are found in the Far Eastern Territory and in the northern part of Korea. Such plants (see Fig. [50]) sometimes prove resistant to even intenser frosts than occur in our parts. In their native haunts they endure frosts of 35° below zero Centigrade in snowless winters and produce fruits of a good flavour, only the layer of flesh is much thinner than in the European varieties.

Here is a list of them.

1. A special type of hairy peach grows in middle Manchuria, where it is known by the name of Mao-Tkha-Or. Its fruits have a juicy flesh of a good flavour, but the skin is so thickly covered with down that it must be pared off before the fruit can be used. Its stone has an obtuse end (see Fig. [51]) and is not always easily detachable from the flesh. Its hardiness to frost is even greater than that of the Korean peach varieties. The fruits ripen by

October 15. In its native haunts in middle Manchuria this species withstands frosts of 35° below zero Centigrade in extremely dry snowless winters with withering north winds. The Americans usually classified it as belonging to the northwest Chinese species, closely related to the peach and known as *Amygdalus Kansuensis*; however, there is an essential difference between these species as regards the structure of stones, and also as regards the structure of branch growth and of the skin of the fruit.

It is already three years since I introduced this species in large numbers of seedlings into the experiment nursery.

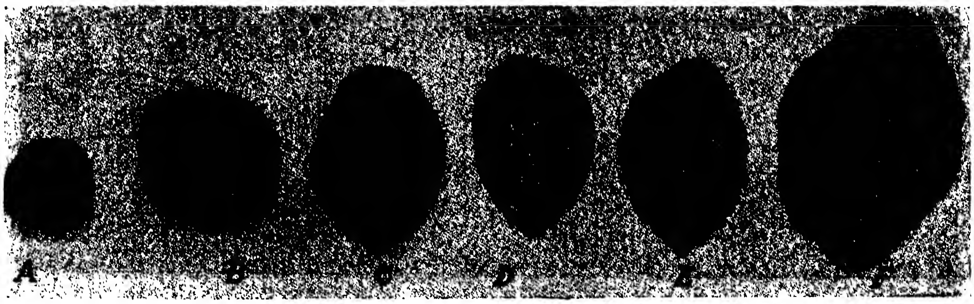


Fig. 51. Stones of peach species:
A—The prickly cherry *Prunus plagiosperma Oliv.*; B—*Prunus Davidiana*; C—*Amygdalus Kansuensis*; D—*Amygdalus Mao-Tkha-Or*; E—Korean *Amygdalus*; F—Peach *Amygdalus*

2. There are several varieties closely related to cultivated strains of apricots, from whose seedlings I have produced here in Michurinsk as many as ten kinds which freely withstand our winter and yield tasty fruits of different shapes. Only late spring frosts sometimes interfere with their early blossoming.

When planting the stones of these peaches and apricots in our parts we may definitely hope (by selection of seedlings and artificial shortening of their usually protracted vegetation period) to obtain new varieties suitable for our section of the country. At present the work with these plants consists only in selection of later-maturing specimens to avoid injury from late-spring morning frosts in our locality. And only when we are through with this work shall we begin to apply to choice individuals various methods of increasing the layer of flesh in the mesocarp by selecting the proper seedlings in the plantings of succeeding generations and also by bringing to bear the influence of stocks of the interspecific hybrid which I call Cerapadus—stocks more nourishing and with a shorter vegetation period of development—and making sure to provide soil to which this species of peach is accustomed in its native country.

As a last resort we may, provided we are very cautious in the choice of male parent (in the sense of avoiding the danger of loss of hardiness under the influence of European varieties), try hybridization, crossing it with southern European and American cultivated large-fruited varieties.

3. A species of peach most closely related to European peach varieties has, as we now learn, been cultivated in North Korea for a long time. Its fruits are much less covered with down than the fruits of the Manchurian hairy peach, Mao-Tkha-Or.

The place where three forty-year-old trees of this North Korean peach have been found[1] is at a distance of fifteen kilometres from the sea, owing

Fig. 52. Leaf of Mao-Tkha-Or

Fig. 53. Black apricot (reduced)

to which it is mostly foggy and there is much less sunshine than in places more distant from the sea. The intensity of the heat of the sun is also smaller. Owing to the cold current from the Sea of Okhotsk and the prevailing north winds, the climate in its place of origin is much severer—the winter is long and snowless during its first half, the soil freezes to a great depth, the summer is cool, the temperature in winter drops to -33°C.

A specific feature of the structure of the Korean peach is the bright-brown velvety coating sharply distinguished on the trunk and on the lower

[1] Found during an expedition in 1929 by N. N. Tikhonov, an explorer of the Far East, who lives in the city of Nikolsk-Ussuriisk [now Voroshilov.—*Ed.*].

part of the main branches—a feature which, as we know, is not met with in any other species and varieties of the peach and its kindred. Further, this species possesses a fairly squatty growth (provided the one-year-old seedlings are properly trained by drying and by pruning of roots) and is more hardy than all other species and varieties both of its wild kin and of cultivated peaches.

Only the Mao-Tkha-Or described above can rival the Korean peach in frost resistance.

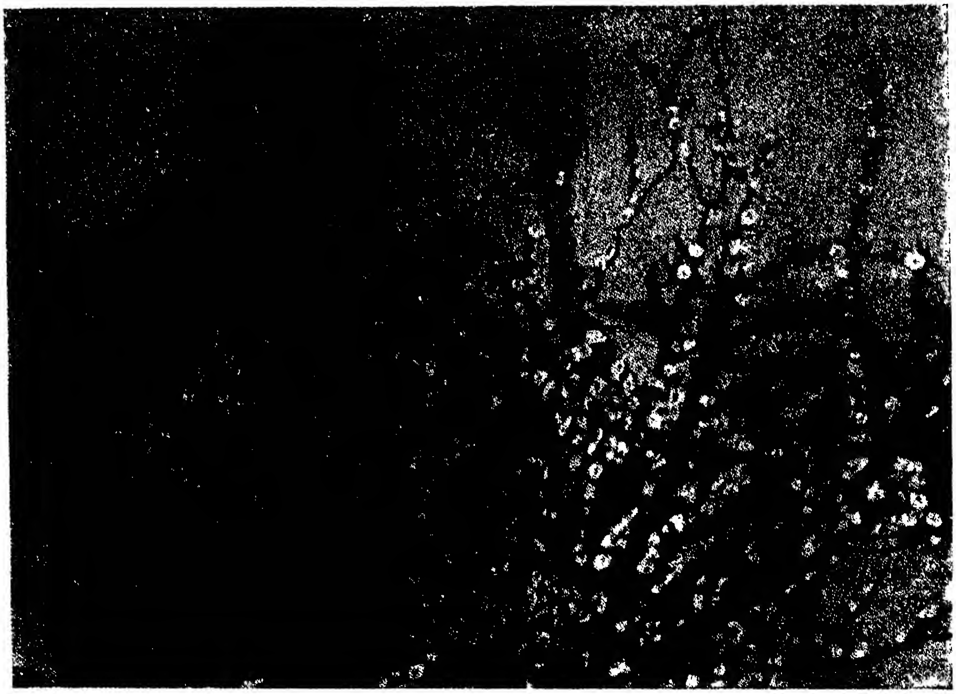


Fig. 54. Ando cherry in bloom

The fruits of the Korean peach are of an oval shape, 30-40 mm. long, 25-35 mm. in diameter, and weighing 10 gr. The skin of the fruit is of a light-green colouring with a scarlet tint on the side, and it is all covered with down, though considerably thinner than in the Mao-Tkha-Or. The flesh, its layer 8 mm. thick, is juicy, of a good flavour, and freely detachable from the stone. The latter—with little knobs and grooves characteristic of all peaches in general—terminates in a sharp thorn.

4. Further, one more eastern species of black apricot is being experimented with—the *Prunus dasycarpa Ehrh.* (See Fig. [53].)

5. Considerable interest attaches to other natives of the Far Eastern Territory—the numerous varieties of the *Prunus triflora Roxbg.*, which I have lately begun to cultivate for the purpose of hybridization with European plums.

6. Another drupe from North China, known there under the name of Ando, may play a big part in the planting of shelter belts. It is the cherry *Prunus tomentosa Thbg.*, a low shrub, not more than 1.5 m. in height, with leaves of a peculiar shape and medium-sized sweet fruits. (See Fig. [54].)

7. Next, the eastern species of what is known as the prickly cherry *Prunus plagiosperma Oliv.*, a rare and singular type with leaves like those of the peach, with flowers of a yellow colouring and long sharp prickles on the twigs, and the stone in the fruit entirely flat, like a button, and marked all over with tiny knobs. Some of its seedlings are fairly hardy. (See Fig. [55].)

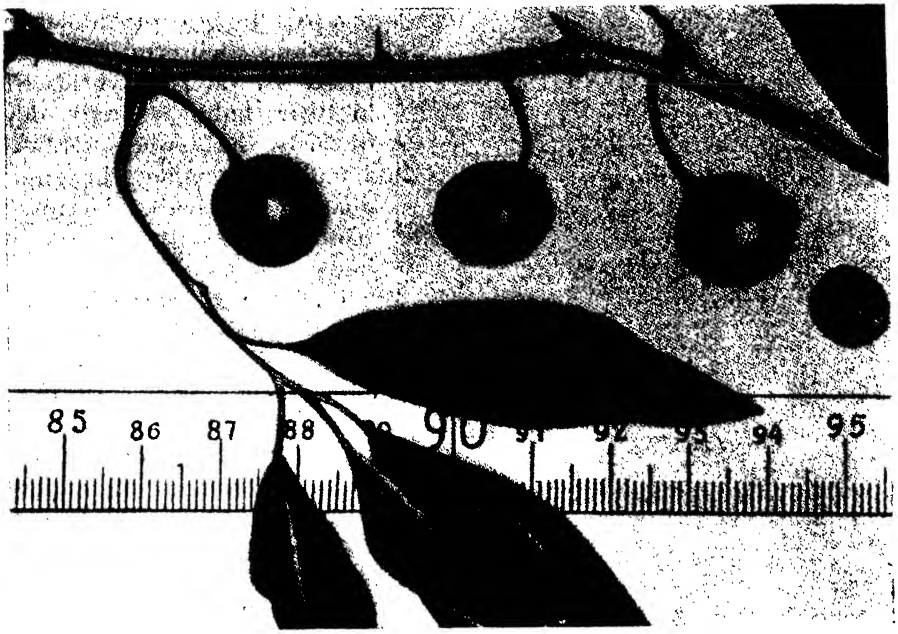


Fig. 55. Fruits of the prickly cherry

8. Seedlings of the dwarf cherry (*Prunus prostrata Labill.*) from the slopes of the Tian-Shan Mountains grow splendidly in my garden. I regard them as very valuable material for breeding cherries of low height as more convenient to take care of and for the introduction of mechanization in the harvesting of the crop.

9. Lastly, various forms (see Fig. [56]) of the American sand cherry (*Prunus Besseyi Waugh.*) and a variation of it, *Prunus pumila L.* (*var. typica*). The latter, incidentally, seems to me much less suitable for our region—the fruits are small and tasteless.

In general, American plants are of much less interest to us than the plants of the Far Eastern Territory.

10. The work with sweet cherries presents a somewhat different picture. Here we are confronted not so much with the lack of hardiness in the wood

and branches to our winter frosts, as with the sensitiveness of the fruit buds to frosts, from which even our old ordinary varieties of sour cherries, the Morellos, suffer. This weakness is a stumbling block in our work with sweet cherries. For example, seedlings selected for hardiness grew up into large thirty-year-old trees with rare and very small yields; finally, in the winter of 1928/29 some of them were killed by the frosts. I am referring here to seedlings of the pure species. As for hybrids of sweet with sour cherries, only those of them are distinguished by hardiness which have deviated in their constitution towards the type of ordinary sour cherries, such, for example, as Krasa Severa. The hybrids which in their habit strongly deviate towards the sweet-cherry type usually bear an insignificant quantity of fruit, because the winter frosts injure the fruit buds.

Fig. 56. Fruits of the American cherry *Prunus Besseyi*

11. Some choice seedlings of the rose Virginia chokecherry (*Prunus virginiana L.*) produce very effective-looking clusters of ruby-coloured fruit which attract everyone's attention; their flavour is much better than that of our ordinary bird cherry. The shape of the clusters differs greatly among the numerous varieties, particularly among the hybrids with sour cherries, with which I have succeeded in crossing them in order to make their fruit larger in size.

Their trees are of small stature, from 2 to 3 m. high. They are quite hardy to the winter frosts in our locality. This plant may prove to be good for shelter belts. Besides, this new type of drupe (*Cerapadus*) is a very important component for hybridization and the breeding of new kinds of fruit trees in Voronezh Region, as well as in more northern regions, not excluding Siberia, where, I may mention in passing, even ordinary bird cherries are always in large demand.

12. There exists also a new variety of my breeding—the Kapolina, which is now being experimented on.

Among the other Korean, Manchurian and Japanese types of stone-fruit plants we find such as bear fruit of enviable quality but some of them possess no hardiness whatever in our region, as, for example, the Kelsey plum and its

variety Poksua among the Koreans; others, like the Japanese bitter cherry (*Prunus japonica Thbg.*) or the Japanese apricot (*Prunus mume Sieb.*) and *Prunus serotina Ehrh.*, are hardy in our parts; however, their fruit being of low quality, they are only fit for hybridization experiments, but not for culture in our orchards.

The same must be said of some wild-growing species of American plums and cherries, and also of the new hybrid varieties of fruit and small-fruit

Fig. 57. Interspecific cross between the chokecherry *Prunus virginiana* and Ideal cherry (*Pr. virginiana L.* × *Prunus Chamaecerasus Jacq.* × *Pr. pennsylvanica* L.). Left, Ideal; right, *Prunus virginiana;* centre, the hybrid

species, most of which prove sterile in our parts, and, although they are hardy to our frosts and blossom profusely, they form no fruit at all or in a negligible quantity.

Thus, a large number of seedlings of *Prunus americana Marsh.*, *Prunus hortulana Bailey* and *Prunus nigra Ait.* in my possession have so far remained sterile. Apparently, because they lack pollinating varieties, or, perhaps, because they blossom very early in the spring, at a time when in our locality the insects which help their fertilization have not awakened to activity.

That is why the various enthusiasts who recommend American plants for us would do better to moderate their passion for the introduction of these varieties into our orchards.

In conclusion I consider it necessary to mention once more the special type of dwarf blackthorn (*Prunus spinosa L.*) which I have produced in

forty years by planting four generations with strict selection for hardiness, dwarfishness and absence of root shoots.

In the regions of Central and Northern Russia there has long been felt the need for this new ideal stock to be used in grafting peaches, apricots and delicate plum varieties for culture in dwarfish shapes. This blackthorn is propagated by the planting of its stones, and it remains constant, without changing its properties.

CHAPTER 16

ABOUT THE TRUE VALUE OF NEW VARIETIES

All originators of new plants, both vegetable and grain, and particularly, fruit and small fruit, should try to avoid causing public sensations by advertising the qualities of new varieties, for this is extremely harmful to our work, if for no other reason than that it arouses illusory and excessive hopes, that are followed by disappointment. On the contrary, in judging the merits of new varieties everything possible should be done to employ a strict standardization, i.e., only the truly useful, first-class varieties which in cultivation yield the best quantitative and qualitative harvests should be released for propagation and distribution; the rest should be rejected. But here is where the difficulty lies, for if, in culling, we base ourselves on the variety's properties in the conditions of the district where the new varieties are being raised, we may reject and destroy many varieties which in other localities or on different soil might prove to be excellent, first-rate ones.

And, vice versa, those that are superior varieties in our parts might be completely worthless in other localities, a point that the originator cannot foresee at all.

Let us take two or three practical examples out of a thousand. I crossed the well-known southern Winkler White Cherry variety with the Vladimirskaya Rannaya Rozovaya and obtained a new hybrid cherry variety excelling in size, flavour and colouring, which I named Krasa Severa. I tested its cultivation on all the different kinds of soils at my disposal, and the result was that the yield from clayey heavy soils was satisfactory, whereas that from sandy soils proved to be a poor one. I wrote about it in that light. Quite suddenly the journal *Progressivnoye Sadovodstvo i Ogorodnichestvo* published an article by the well-known nursery horticulturist, Reshetnikov of Samara,[1] containing the following statement:

"Michurin himself does not know what a treasure he has produced in the Knyazhna (Krasa) Severa variety of cherry. Upon being propagated in our parts it turned out, in the first place, that by comparison with other varieties of cherry this one develops rapidly and begins to bear fruit early, and, secondly, its yield is so high, that everyone comes to the nursery to admire these saplings and marvel at their fecundity." But that is not all. In the city of Omsk, Siberia, this variety splendidly withstands frosts of 35° below zero

[1] Now the city of Kuibyshev.—*Ed.*

Centigrade, yields an abundant crop, whereas even the pure variety of Vladimirskaya cherry perishes there from the frost without exception. How could I foresee such a phenomenon? So that even now, when I have the actual facts at hand, I cannot bring myself to write that the sweet cherry hybrid is suitable for cultivation in Siberia.

Here is an example of another kind. I have released for sale a new variety bearing outsize fruit which I named the 600-gram Antonovka, obtained from a sport deviation (bud variation) of the Moghilyovskaya Antonovka Belaya apple; it has a fine, highly attractive appearance, and ripens in late autumn or early winter. Despite inferior storage properties, its fruits are valued for their beauty and flavour much more highly than the ordinary Antonovka both in these parts and in districts farther north. Further, we receive enthusiastic reports about this variety from localities which claim that in their parts its fruits keep fresh until spring. Yet in the town of Voronezh this variety is priced cheaper on the market than the ordinary Antonovka. It appears that the determining factor is what variety the inhabitants of each particular locality are accustomed to use in their diet, something the originator cannot possibly know.

A third example. Surely, new, excellently flavoured varieties, such as, for example, the Kandil-Kitaika variety, a product of mine, should not be rejected merely because they may lack hardiness in the more northern parts of the Soviet Union. It is impossible to foresee the northernmost boundaries of similar varieties; this requires the data provided by many years of observation in northern localities and under different conditions. Yet another example: the highly productive and valuable variety of pear, Michurin Beurré Zimnaya—another of my products—which ripens in winter storage, yields unprecedentedly large harvests in our region.

In the city of Michurinsk (Ukrainskaya Street No. 120), sixty-four ten-year-old Michurin Beurré Zimnaya trees planted on a half-hectare plot cultivated by citizen Davydova in a most primitive fashion, which is almost tantamount to her not looking after it at all, used to yield good crops both qualitatively and quantitatively, but in the winter of 1929 the greater part of the orchards was killed by frost. A recent report from citizen N. Dianov, living in the Beryozovsky District, Ivanovo Region (600 km. north of the city of Michurinsk) states that in the soil conditions of those parts this variety is a hardy one. The same variety grows satisfactorily in the Moscow District.

The same must also be said of the immunity of new plant varieties to diseases in general and, in particular, to harm from fungus parasites and to damage by insects. All this depends to a great extent on the soil and climatic conditions of each particular locality. The sterility of individual varieties also depends to a similar degree on such conditions, as is also confirmed by the data of North American horticulture. In a word, our local appraisals of the merits of new varieties, no matter how complete and objective they may be, not only cannot be applied to entire districts, but even within the bounds of a single district must be limited to comparatively small territories with approximately identical climate, landscape and soil.

Where the air and soil are very dry, even in a warm climate, this does not prevent the development of frost resistance in plants, while, on the contrary, a damp atmosphere and humid soil in a warm climate make plants extremely delicate and prevent them developing frost-hardiness.

In some cases the training of hybrids at an elevated temperature, but in extremely dry air, does not hinder them from developing the property of frost resistance, as shown by an example taken from a description of the origin of new species of Mongolian apricots and a new seed-raised apple variety called Paradox, that grew in a heated inhabited room where double window frames were retained in the summer. For nine years this seedling was never once taken out into the open air; nevertheless, after being grafted in the garden in the tenth year it excellently withstands all the local frosts and bears large fruits of fine flavour. Hence, we can hope to obtain species which will withstand our climate from plants originating in dry and mountainous regions, though with a warmer climate than ours. In general, it may be presumed that considerable dryness of the air and soil, while hindering the luxuriant growth of plants, may at the same time serve to give a correlative stimulus to the development in the plants of a relative hardiness to frost.

It is only on this basis that I recently procured the seeds of a wild species of fig tree which grows in a very dry mountainous locality, and I am making an attempt to introduce this species of fruiter into cultivation in our locality.

First published in 1929 in
I. V. Michurin, *Results of Half a Century of Work in Producing New Varieties of Fruit and Small-Fruit Plants*

GENOTYPICAL ALTERATIONS IN INTERGENERIC CROSSES

Genotypical alterations in the structure of the details of the organism of intergeneric hybrids, particularly at the earliest stage of their development, are an extremely rare phenomenon in the vegetable kingdom. Therefore, not a single more or less graphic and more or less comprehensible photo of these biological facts, which are so highly important to us, could until lately be found in the entire world literature on this subject.

The absence of data and of any clarity on this question is primarily explained by the fact that until quite recently the overwhelming majority of prominent botanists have completely denied the possibility of intergeneric crosses.

In denying the possibility of intergeneric crosses the above-mentioned "scientists" have apparently overlooked the fact that it is primarily by such means alone, by means of interspecific and intergeneric crossbreeding, coupled with the action of the powerful factors of environmental influence, that new forms of plants could spring up in nature in the course of millions of years, as a result of which there exist at present such a vast quantity of the most diverse plant forms.

The powerful stimulus of the October Revolution awakened the creative abilities of millions of working people in the Land of Soviets, and the labour-

ing population, who, under the direction of the Communist Party of the Soviet Union and its leader, Comrade Stalin, are now building Socialism on one-sixth of the earth, has obtained the opportunity of taking a conscious attitude to their own life.

What is of prime importance for us to know at present is that we can already intervene in the actions of Nature.

By intelligent intervention we can now greatly accelerate form-building of new species and bend their constitution in a direction most useful to man.

The most urgent task that confronts us today is to find the means by which we can more easily and more successfully intervene in Nature's activities and thereby reveal her "secrets."

On the basis of experiments and observations in the sixty years of my continuous work, I find that the path lies through artificial crossing, through hybridization.

Speaking of hybrids of perennial fruit trees, I consider it necessary in the first place to make it generally known that my interspecific and intergeneric crosses proved successful only when effected at the first blossoming between such hybrid seedlings as were obtained by crossing plants (both the male and female parents), even if of the same species, but remote from each other geographically (as regards their native habitat).

I repeat that interspecific and intergeneric hybridization can only be successful at the time of the first blossoming of the tree, and then not of every tree, but only of some hybrids, obtained, as my practical work has shown, from definite and suitable combinations of parents.

The other blossoms of the tree used for this purpose, which in this case have not been subjected to artificial crossing, should be destroyed without fail, so as to preclude the possibility of their fertilization by the pollen of the same species.

Sometimes, however, an interspecific or intergeneric cross proves unsuccessful even when all the above-mentioned conditions are strictly observed. In such cases I resort to the following special method: immediately before the act of fertilization I place on the pistil of the blossom which is undergoing pollination a bit of the stigma from the pistil of the male parent; this helps to intensify the activity of the pollen tubes on the alien stigma of the female parent and heightens the effectiveness of distant crosses.

It must be noted besides that interspecific or intergeneric hybridization is sure to fail if we perform it in the second year of the tree's blossoming, particularly if at its first blossoming it formed fruit from the pollen of plants of the same species.

The seed obtained from interspecific and intergeneric hybridization are for the most part deformed and tend to germinate quickly: in stone fruits, for example, they are almost always with sprouts while still inside the fruit, owing to which they cannot be subjected to any kind of drying. Such seeds must be planted into a box with earth immediately after they have been removed from the fruit, and the box should be kept in a cool but not frosty place.

In this case sprouts appear at various intervals, i.e., during the entire winter period. When spring comes the seedlings thus obtained are transplanted into beds.

In conclusion I consider it expedient to cite here facts, confirmed by photos, relating to what I have obtained as the result of intergeneric crossing. In the particular experiment the female parent was a second-generation seedling of a new hybrid variety which I have described under the name Antonovka Shafrannaya (produced by crossing an Antonovka-Kamenichka with a Reinette d'Orléans), which in the spring of 1932 formed three blossoms for

Fig. 58. Part of seeds derived from fruit of seedling F_2 Antonovka Shafrannaya fertilized by a mixture of pollen from various species of fruit and berry plants (natural size)

the first time. These blossoms (under conditions of strict castration and isolation) were fertilized with a mixture of pollen from different species of fruit and small-fruit plants—sour cherry, plum, pear, Juneberry, mountain ash, currant and gooseberry.

The three fruits obtained from this cross had the usual oval shape of medium-sized apples and a pale yellow colouring with dull greyish veins. Exact measuring and weighing have shown the following:

Size of fruit (average for the three): length 55 mm., diameter 63 mm., and weight 83 gr.

Stem: 24 mm. long, fairly thin, light brown, placed in a broad regular-shaped cavity.

Core: of small size with open carpels of bulbous form, containing 10 seeds in each fruit. Altogether there were 31 of them, all without exception of different peculiar shapes having nothing in common with the usual shape of seeds of fruit plants (see Figs. [58 and 59]).

Flesh: fairly solid, juicy, of an excellent sweet flavour with refreshing acidity.

The fruit ripened in late autumn.

As for the tree itself of this seedling which was used as maternal plant, it should be said that it is quite hardy to winter frosts and is small and squatty. Because of this the plant may prove a standard variety for training to form

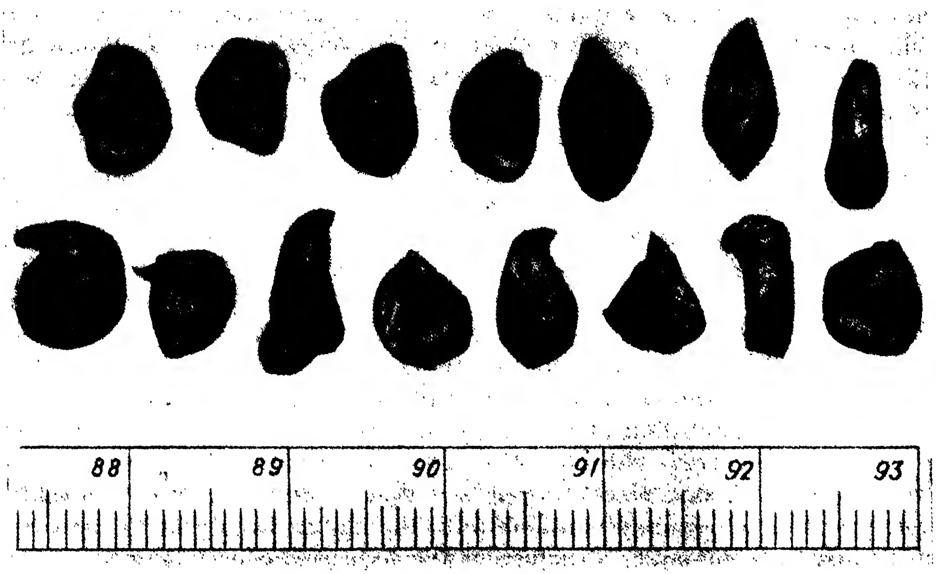


Fig. 59. Part of seeds derived from fruit of seedling F_2 Antonovka Shafrannaya fertilized by a mixture of the pollen of various species of fruit and berry plants (enlarged)

and for planting in orchards in intervals between rows, particularly where only dwarf trees are cultivated, and thus fill a big gap now existing in our assortment.

Facts concerning the development of the seedlings of the intergeneric hybrids thus obtained will be reported later.

First published in 1932 in
Plodoovoshchnoye Khozyaistvo, No. 11

SOME PROBLEMS OF METHOD

IN WHAT RESPECTS DO MY METHODS OF WORK DIFFER FROM THE METHODS EMPLOYED BY OTHER SPECIALISTS

Before proceeding to discuss the difference between my methods of work and those used by other specialists, it is necessary to know where and who in the U.S.S.R. besides myself has been occupied with the selection of fruit trees and shrubs and has produced any new varieties of these plants. With the exception of the scant works of Kopylov, Spirin, Bedro and Professor Kash-

chenko, each of whom has produced three or four new varieties of plants of third-grade quality, I do not know of a single horticulturist working to produce new varieties on a scale worth mentioning. Therefore, I cannot explain the difference between my methods and those of other workers in the same field, so far as the breeding of apple trees and pear trees, cherries, plums, apricots, etc., is concerned. As to the methods employed by foreign horticulturists, their having been elaborated in the conditions of climate and soil entirely different from those of the U.S.S.R., makes them inapplicable in our country in most cases.

Furthermore, as the readers probably know, neither in any of the West European countries, nor in America, are there any such institutions at the present time, working exclusively on the production of new orchard varieties of fruit trees and small-fruit shrubs. Perhaps some of the readers will not agree with my statements. I am not going to dispute such opinions for the reason—if for no other—that many agriculturists in their approach make no distinction between annual herbaceous plants and perennial fruit trees. Actually there is an immense difference between these plants in the length of time during which they are subjected to the action of environmental factors that affect the constitution of the newly developing plant organism of every new variety. Very great indeed, I repeat, is the difference between the complete life cycle of, say, Mendel's pea and that of any variety of apple, the development of which may continue until the age of twenty or thirty years. During this time the entire structure of the hybrid is often changed beyond recognition under the prolonged influence of diverse environmental factors, with some of its properties vanishing so completely that no trace of them is left, others developing, and with still others becoming manifest. Besides, sport variations displaying properties of some of the grandparents of the parental plants likewise occasionally occur.

Many people are inclined to consider that the difference between my methods of rearing the plants and the general rules of horticulture lies in the fact, that, when laying out a nursery, I never use deep turnings of the soil, never give the young hybrid plants any fertilizers, plant these hybrids very densely, etc. My first answer to these criticisms will be that it is one thing to run an orchard with already existing varieties of plants—here there can be no denial of the necessity to keep up a high level of culture in rearing the plants—and quite a different thing to produce and to rear new fruit-plant varieties, and these two things should never be confused. I have come to the Spartan regimen of rearing the plants after having thoroughly studied the life of fruit trees and small-fruit shrubs belonging both to the wild species growing in our forests and to the cultivated varieties bred in our orchards. The difference in longevity between the first and the second is very significant. Forest plants live in general four times as long as cultivated ones and, what is most interesting, the better the treatment the plants are given, the shorter becomes their life span. At the first superficial glance the main cause of this phenomenon appears to be the more rapid exhaustion of the plant organism as the result of its fruit bearing being intensified by cul-

ture. But is that quite so? Don't we see in our forests wild-growing apple trees and pear trees yielding abundant crop every year and living more than two hundred years, while in our orchards they barely reach the age of fifty? For example, apricots and peaches grown in orchards rarely live over fifteen to twenty years, whereas in the forests of Manchuria and the Caucasus the same species attain the age of seventy and eighty. Even plantations of black currant and blackberry in our orchards get exhausted and have to be renewed and transplanted to a fresh site every eight or ten years, while in the forests black currant lives and yields abundant crops of large berries for almost a hundred years, remaining in the same place all the time. On viewing this phenomenon from the purely materialistic standpoint, it becomes evident that the cause of the shorter life span peculiar to all these coddled "bourgeois" of the plant world grown in our orchards is the loss of the capacity for "self-activity" in cultivated plant organisms. This is the result of the constant interference of man—lasting for hundreds and thousands of years—who provided these plants with ready conditions of comfort thus hoping to secure intensified fruit bearing. It is for this very reason that the majority of cultivated plants, having lost their property of self-activity can no longer do without the care of man.

Already at the very beginning of my work in horticulture I observed that the hybrid seedlings grown on better soil—such as was fertilized and turned over—were by far the inferior in their resistance to all kinds of adverse climatic conditions when compared with the seedlings of the same hybrids grown on unfertilized sites with sandy soil; true, among the former a greater number deviated in structure towards the cultivated form. During the first decade of my work I still had doubts about the necessity of altering the regimen in rearing hybrid seedlings in the sense of affording them a better opportunity to develop the capacity for self-activity. I, naturally, supposed that any severe treatment in rearing these seedlings despite the culture properties inherited from the parent plants, would result in the appearance of wildings only, and in their incapability of producing the large-sized fruit of cultivated varieties. But fortunately it so happened that a few hybrid seedlings reared under relatively severe conditions gave large fruit of the finest quality on the sixth year after their germination, whereas all the coddled specimens raised in the best conditions were all destroyed by frost. I was therefore compelled to transfer my entire nursery to another site with a more meagre soil, and I did it without any hesitation. It was a venturesome matter to transfer the entire nursery, but later on it proved to have been justified and gave good results. Now this is where the difference lies between my methods and those of other horticulturists. Further, at the beginning of my work I used to cross the best foreign varieties of fruiters with our hardy local ones, but later such hybridization turned out to be a serious mistake, and it became evident that some different principle of choosing parents must be adopted.

The reason for that was, that when our hardy local cultivated varieties were pollinated with the pollen of the best foreign varieties, hybrids were

obtained in the vast majority of which characters peculiar to our varieties proved to be dominant; subsequently these qualities developed, while the properties of the foreign varieties failed to manifest themselves and remained in a latent state. This was due to the fact that the hybrid seedlings were grown under the conditions of soil and climate habitual to our varieties. Thus, for example, although the fruit of hybrid pears had a fine taste, they were, however, small and ripened in summer. Both these features are peculiar to our Russian varieties of pears. In order to avoid the undesirable results of such unsuccessful combinations of mates, I began using as the hardy components for the crosses forms from very distant localities (in this particular case from the Far Eastern Territory of the U.S.S.R. and from Manchuria). By fertilizing these hardy forms with the pollen of the best foreign varieties, I succeeded in attaining an equal participation of both parents in the hereditary transmission of their properties to the hybrids, since they were now to the same extent deprived of the habitual environmental conditions of their native localities. Still another important advantage of such hybrids deserves being especially mentioned. They are all distinguished by their outstanding capacity for adaptation to environmental conditions of a new locality. So I rear hybrid seedlings without deep turnings of the soil, and without any fertilizers until the first appearance of fruit-buds. Only then do I give them some liquid fertilizer and cover the soil right under the young plant with a layer of fresh manure to obtain better-formed and larger-sized fruit. The layer of manure also affords some protection against over-drying of the soil. I plant the seedlings rather densely. After the first three-four years of bearing, when the new variety has already fully attained stability, some cuttings are taken from the mother-tree for the propagation of the new varieties by grafting on stock. If some defects in the hybrid's qualities are revealed after the onset of bearing, at times, although by no means in every case, some of these defects can be either partially or entirely removed by the expedient choice of various kinds of stocks or even partly by grafting as mentors cuttings taken from some other varieties. As for the origin of new species of plants, they appear rather rarely as a result of intergeneric, sometimes also of interspecific, hybridization. Similar phenomena arise by mutations, as well.

Some of the excursionists visiting our institution—their number reaches five thousand every year—at times ask me such questions: "Why is it necessary to produce new and improved varieties, when we have plenty of our old varieties?" I have to repeat to such naive persons what I have written time and again as far back as forty years ago in many of my articles: in nature the forms of life are not frozen and fixed; life is incessantly moving and continuously changing, and all living creatures that for some reason have come to a standstill in their development are inevitably doomed to extinction. Much of what seemed of old to be the best in its perfect adjustment to conditions of life that prevailed in the past, nowadays proves to be unfit and must be replaced. The same holds true with respect to our old varieties of fruit plants, most of which in the old days, when labour used to be gratuitous or cheap, were more or less suitable for commercial

cultivation; in our days they are not only unworthy of being cultivated, but are a pernicious litter contaminating our orchards. Moreover, many of our old varieties have already lost their fine qualities or, as they say "degenerated" and must give place to young new varieties.

I shall conclude this article by saying that the work of qualitatively improving fruit-plant varieties is of colossal importance for the future life of all mankind. That is why this activity must be unceasingly promoted and the necessity of working in this field must be impressed by all means into the minds of the entire population of the Soviet Union.

CHOOSING COMBINATIONS OF PARENTAL PAIRS OF PLANTS

The following conditions should be observed when combinations of parental pairs of components are chosen for crossing fruit trees:

1. For the role of maternal plant preference should be given to own-rooted specimens, not to ones grafted on to stocks of wild varieties.
2. Maternal plants should be chosen from among local frost-hardy strains, even if half-cultivated, or they should be taken from geographically distant localities but with similar severe climatic conditions (I must note that the latter combinations yield the best results). Hybrids obtained as the result of such crossings become better and more quickly adapted to the conditions of the external environment of the new locality.[1]
3. As for the choice of the male parent, preference should be given to varieties whose fruit possess the best qualities, mostly brought from warmer lands with better climatic conditions, and it is almost immaterial whether an own-rooted or a grafted plant is taken for the role of father.

ON THE REARING OF NEW VARIETIES

It is necessary to rear varieties more resistant both to frost and to the harmful influence of our deeply continental location. This is accomplished by rearing hybrids in the early stage of their lives in dry elevated spots or in places which, while not elevated, have sandy soils permeable to water.

ABUNDANT YIELDS AND EARLY FRUITING AS FUNDAMENTALLY IMPORTANT PROPERTIES OF SUPERIOR VARIETIES

The prime task now confronting every breeder of new varieties of fruit and berry plants is to produce such as, in addition to possessing good flavour, attractive appearance, frost-hardiness, immunity to disease and capacity to

[1] The latter combination has, in addition, the advantage that it precludes the dominance in the hybrid of the local strain as the more accustomed to the climatic conditions of its native habitat.

resist pests, are early fruiters and abundant bearers. The task is, indeed, a very difficult one, particularly when we consider that fruit growers lack a firm base on which to rely in this matter. Let us examine in detail, and in their order, the principles and observations pertaining to this question.

We shall see, first of all, that seedlings of one group of apple-tree varieties do not begin to bear fruit before seven or eight years, while some of the same group, actually the best,[1] begin still later, only after fifteen to twenty years. All the ingenious contrivances for accelerating the onset of fruiting, far from being of any avail, cause nothing but harm when applied by ignoramuses posing as experts in this field, as they divert young breeders from the right path.

For example, to accelerate the onset of fruiting they graft cuttings of a young seedling onto the crown of an adult tree; they naively point to the work of Burbank as an example of this method, without themselves having tested it, and without taking any account whatever of either California's subtropical climate or of exactly what results were obtained by Burbank from grafting the young seedlings onto the crown.

One feels ashamed of such theoreticians as, for example, the late Zhegalov, and hundreds of other compilers who declare and affirm that Michurin had no grounds whatever for rejecting this method of accelerating the initiation of fruiting. If that were so, Michurin would long ago, in the course of his sixty years of uninterrupted labours, have convinced himself of the utility of applying this method. Even now, however, he asserts that this method will bring the breeder engaged in hybridization nothing but harm. And this is so if only for the fact that the influence exerted by the work of the leaf system of the entire crown and of the entire root system of the stock, on the extremely small part of the young seedling's grafted cutting always changes its structure and, what is more, in a negative direction. But that is not all. Are these ignoramuses aware that the overwhelming majority of hybrid seedlings have, in the first year of their growth, the structure almost of the wild species, and that only in the following years do they gradually change in the direction of the cultivated state, acquiring a completely cultivated form only when they are fully mature. But even in this case the fruits of the first year of fruiting are imperfect both as regards flavour and external qualities, i.e., size and colour; they improve only gradually, during the first few years of fruiting. In proof of this we have a whole series of photographs of the fruits of new varieties taken during their first few bearing years.

These changes in the development of all parts of the hybrid's organism take place only under the influence of the work both of its leaf and of its own root systems. When the cutting of a young hybrid is grafted onto the crown of an adult tree of totally different structure in all its parts, it must inevitably be subject to the influence, and particularly strong influence at

[1] And, on the contrary, the earliest to bear fruit are hybrids that incline toward the wild species, and hence are unfit for cultivation.

that, of the adult stock tree which possesses quantitatively superior leaf and root systems. And the cutting of the young hybrid, transferred and grafted while its organism is only in the initial process of formation, is naturally bound to change, and inevitably does change, its structure as a result of the influence of the stock. Thus, in the first place, the development of the hybrid's structure towards the cultivated type stops at the point it reached when the cutting was taken from the young hybrid seedling,[1] and, in the second place, its structure will change further as a result of the strong influence exerted by the work of the entire leaf and root system of the adult stock, i.e., a vegetative hybrid will be obtained whose parents were three varieties. As a result, fruits are obtained of incomparably worse quality than those borne by the seedling itself.

Not to believe these indisputable arguments and, what is more, to refute facts without personally verifying them in practice is an act almost bordering on sabotage. Let opponents who have not themselves produced a single new variety show a practical example confirming their assertion, or, if they have none of their own, let them examine in our nursery several adult trees grafted with cuttings of young hybrid seedlings, and then they will see the result of such labours.

I have obtained a somewhat better result in my work on accelerating the initiation of bearing in hybrid seedlings by bud grafting them on dwarf stocks; this was particularly evident in grafting pears on quince. Here, at least sometimes, the influence of the stock did not worsen the quality of the fruits of the grafted hybrid seedling.

Success in considerably accelerating the onset of bearing in a seedling has also been obtained by applying the mentor method, i.e., by whipgrafting to its small stem springs with fruit buds of an old, particularly prolific variety. Nevertheless, in many respects, neither of these methods yields satisfactory results.

Much better and more reliable results are obtained from breeding new varieties with a special inclination toward earlier bearing. This is achieved by the expedient selection for crossing, of parental pairs already possessing the qualities we require. The fact is that in examining the diverse qualities of all varieties of fruit plants in general, and of apple and pear trees in particular, I paid attention to those which are most suitable for solving the problem facing us. I shall explain in greater detail. All our apple-tree varieties and, in part, our pear trees, have to be divided into four groups: the first group covers varieties whose trees form fruit buds when the wood of the sprouts is three years old; the second group covers trees which form fruit buds when the wood is two years old; the third group covers those which form buds on the previous year's one-year-old shoots, and the fourth group covers varieties, extremely rare, it is true, whose trees produce fruit buds on young sprouts that have grown in the spring of the same year.

Well then, the trees of the varieties of the fourth group are distinguished for their regular, annual and abundant yield. Two-year-old bud grafts of

[1] As is confirmed by Prof. Hans Molisch in his *Pflanzenphysiologie*, p. 264.

these varieties already bear fruit. Pippin Shafranny, the new variety which in the first bearing year bore fruit on a young sprout of that year's growth belongs, in part, to this category. In the following years fruit buds were also formed on the wood of the previous year. This variety is notable to this day for its abundant yield year in and year out. An analogous property is also met with in the Shafran-Kitaika (see Fig. [60]), a new variety bred by

Fig. 60. Development of a fruit bud of Shafran-Kitaika:
A—Growth shoot with two-year-old wood; *B*—fruit bud formed on one-year-old wood; *C*—fruit set on one-year-old wood; *D*—growth shoot in spring of same year formed from fruit bud alongside fruit; *E*—blossoming of upper part of this young shoot

me. From this variety's fruit bud, marked with the letter B, after the blossoming and the formation of the fruits C, there appears next to the fruits a new sprout D on which blossoms E develop anew, and fruits are formed for a second time.

We find this property to a still more considerable degree in the Golden Delicious apple tree, a chance growth from a seed in West Virginia.

By selecting such and similar varieties to serve as paternal and maternal parents and crossing one with the other we can select from the hybrid seedlings specimens with the most strongly developed property of early bearing in varieties that can yield fruit on two-year-old grafts.

This is the only method by which we will fulfil that very worthy task: "To breed early- and abundantly-bearing varieties."

To fulfil this task seeds of the original fruits of Golden Delicious apples brought from America by Academician N. I. Vavilov were planted in the spring of 1933. A hundred seedlings were obtained possessing identical habit both as to form of leaves and their petioles and as to form of sprouts and the buds on them, which proves that here selfing, i.e., self-fertilization, took place. Further observations will show whether this assumption is correct or not. This is particularly important to us, if for no other reason than that otherwise we shall be unable

Fig. 61. One-year-old seedling of Golden Delicious apple in loose, rich soil

Fig. 62. One-year-old seedling of Golden Delicious apple in poor, dry soil

to obtain this original American variety, inasmuch as the dozen trees of this variety received from America have leaves of different forms, and hence raise a doubt as to the genuineness of the variety. Besides, their resistance to the climatic conditions of our locality will be much lower than that of our own seed-bred variety.

In addition, as may be seen from the illustrations (Figs. [61 and 62]), a hitherto unknown phenomenon can be observed in the Golden Delicious seedlings. It is expressed in an especially vigorous development of the root system, as a matter of fact so vigorous that the roots develop even above the surface of the ground along the lower part of the stem not only above the spot where the cotyledons are found but also between the lower true leaves of the seedling. This already indicates the specific structure of this type of apple tree, a fact extremely important for hybridization in the future, for crossing it with other varieties, for breeding by selection particularly prolific and precocious varieties.

PROOF THAT THE STOCK INFLUENCES THE GRAFTED VARIETY

In 1888, a hybrid was obtained from the seed of a Vladimirskaya Rannaya sour cherry which had been fertilized with a Winkler White Cherry. In 1891 the hybrid produced its first fruits, which were of a uniformly white colour, but for a scarcely noticeable pink hue on the side turned to the light. In 1892 and 1893 the fruits were altogether white. In 1893 I proceeded to bud this variety on seedlings of the common red sour cherry, for which purpose all the shoots on the tree were removed for cuttings in July. In the middle of August the tree began to produce a second growth, and in November while in full sap it was caught by 10° of frost, which caused it to perish. In 1897 all the bud grafts began to bear, but the fruits were all of a uniform pink colour.

Subsequently, when further propagation was performed by bud grafting from cuttings, this time taken from the first grafted individuals, the bud grafts on reaching maturity, produced fruits of an even darker colour and increased the height of the tree. This change of colour was obviously due to the influence of the stock of the red sour cherry.

Another graphic example was the process, described below, of producing a hybrid of the attar rose, the flowers of which, again owing to the influence of the stock, lost their yellow colour.

FORCEFUL INFLUENCE OF QUINCE STOCKS ON YOUNG HYBRID PEAR SEEDLINGS

As is commonly known, some cultivated pear varieties develop splendidly when grafted on quince, yielding fruits of even better quality than on pear stocks, while the stature of the tree is considerably lower on quince.

This is due principally to the influence of the quince stock with its weakly developed root system, whose natural rate and limit of growth are far lower than those of the pear. The stock cannot absorb all the substances elaborated by the luxuriantly developing scion, and they accumulate in the latter, chiefly in the form of carbohydrates (for the most part sugars and starch), "crowding tighter" into the fruits, which as a result grow better and are sweeter on dwarfed trees. But even though quince is the very best, unexcelled stock for pears, yet such a distant stock (belonging not only to a different species, but to a different genus, though some botanists mistakenly class it in the same genus, as *Pyrus Cydonia L.*) cannot supply the place of the pear's own roots, and pears grafted on quince seem to "feel" the poisoning with alien saps and bear fruit with great intensity until they finally perish. Such pears perish nearly ten times sooner than own-rooted trees; the latter live to about 200 years, while those grafted on quince have a life span of only some 20-25 years.[1] It has to be said that the number of pear varieties which

[1] The grafting operation itself, even if onto pear seedlings, and even if carried out to perfection, usually reduces the scion's length of life by more than half, as it is too great a shock for the organism.

grow effectively and fruit better on quince is not as large as is usually believed.[1] Most varieties of pears have an "antipathy" to quince. These varieties do not thrive on quince—they either cannot grow on it at all, or if their buds or cuttings do take on it, they develop poorly, are sickly and perish before long. However, the majority of these "antipathetic" varieties can be made to grow on quince by means of intermediate grafting. This is done by first grafting on the quince a variety that does thrive on it (a "sympathetic" type), and it is onto the stem produced by this type that the "antipathetic" variety is then grafted. And alien as the quince organism is to the pear, factors in favour of using it as stock are that the fruits of pear on quince are frequently improved and that a greater percentage of the energy and sap goes for fruiting than for vegetative growth.

It is known, further, that an organism accustoms and adapts itself to environmental changes very much more easily at an earlier age, before it is completely formed. As far as I was able to study the point in my practical work, fruit-plant hybrids at an early age are particularly plastic and susceptible to change, and adapt themselves with remarkable ease to the various external conditions of their environment and to symbiosis with other species when grafted.[2] In grafts of pear on quince, this is also to be observed. And if, let us say, an old pear variety that is "antipathetic" to quince cannot be made to grow satisfactorily on the latter because the two are not "used" and adapted to each other and because of the (in all likelihood mostly chemical) unconformity between them, there is immeasurably more hope of doing so if one works with infant plants.

Prompted by such considerations, I made the experiment of grafting upon young two-year-old quince seedlings twenty-eight new and not yet bearing pear varieties selected for their outward characteristics. This was done in order to "accustom" these pear types to quince, and also in order to study the influence of quince upon young, only just forming varieties and find out how the latter react at an early age to quince stocks—whether they are sympathetic or antipathetic to them. On an average, twelve buds of each variety were grafted. The results were as follows:

100% of the buds took in	9	varieties
50% " " " " "	12	"
25% " " " " "	7	"
Year-old growth from buddings 1 metre in	7	"
" " " " " 0.5 " "	14	"
" " " " " 0.15 " "	7	"
Shoot ends thicker than in original plant in	4	"
" " of equal thickness with original plant in	11	"
" " thinner than in original plant in	13	"

[1] Naturally, these varieties too are adversely affected by unfavourable conditions of soil and climate.

[2] And also "adapt" and "accustom" themselves to the natural method of propagation by grafting, and, being more pliable in all respects, endure the actual process of union more easily, assimilating saps of alien origin and composition.

Some interesting points are revealed here. Propagating hybrids at an early age by grafting them on quince[1] for the most part greatly injures their properties. This is readily discernible even to the eye, by the outward appearance of the year-old growth. It is also partially indicated by the figures I have quoted, which show that in the largest group of varieties in this experiment, the one-year-old shoots are thinner than in the original plant (and thickness of shoot ends is one of the major characteristics of "culture," it is connected with the valuable properties of a variety). Evidently we see manifested here the vegetative influence of the stock upon the young organism of the hybrid, which is still far from having developed the stability possessed by an adult, fully established variety. Only a very few of the pear types exhibited a deviation for the better; in the overwhelming majority of cases, the quince seedlings proved unsatisfactory mentors. The influence of the quince stock also manifests itself very differently in different varieties as regards various details of outward appearance. Besides the thickness of the shoots, the degree and sharpness of the serration of the leaf margins becomes greater or less, and so does the pubescence on the leaf blades, the thickness of the blades, the density of venation, the size and roundness of the buds, the length of the petioles, etc.

In succeeding years, as the growth from the buds develops further, there may be certain changes, though most probably they will be slight. The matter is also complicated somewhat because, as I have observed, the adaptation of plants to symbiosis requires a certain period of time, the length of which depends in no small measure on external conditions too. Things like injuries of various kinds, affliction with fungous diseases, etc., not only retard the development of plants, sap their vitality and tend to make them run wild, but also hinder such "adaptation."

Among the one-year-old bud growths we are examining, none proved to have a particularly dwarfed, squat habit or sufficiently thick shoot ends. The reason is principally that, as mentioned above, the stock was not a layer-propagated, but seed-grown quince—seedlings, which on account of their youth could not exercise as strong an influence as is usually exercised by an adult organism or parts of it, as, for example, layers or cuttings.

In passing I must remark that more dwarfed and hardier types of the quince itself should be bred by hybridization and selection. That is quite possible, as proved, for example, by the Severnaya quince bred by myself—a choice hybrid seedling obtained by crossing the wild Caucasian *Cydonia oblonga Mill.* with the Sarepta quince *Cydonia vulgaris Pers.* The Severnaya quince is more resistant to frost and evidently to dry soil too, and is particularly interesting because it can be propagated much more easily than any other quince variety by planting cuttings straight in the ground in the spring or even in early autumn.[2]

[1] To say nothing of grafting them on wildings, which in most cases hopelessly corrupts the young variety's properties.

[2] Evidently, this is due largely to the fact that I trained it from an early age to vegetative propagation by cuttings; and besides force of habit, selection too exerted its

Then we must take into account that, suited as is the quince—*Cydonia pyriformis Kirchn.*—to serve as stock for pears, it is nearly as well suited, in the form *Cydonia maliformis Mill.*, to serve as a dwarf stock for apples; particularly if we begin to graft new hybrid apple varieties onto it while they are still young and each year make new bud grafts from the shoots put out by bud grafts of the year before. Accustoming apples gradually to symbiosis with quince, we shall in the end evolve new apple varieties capable of growing well on a quince stock.

Further, an experiment has also been undertaken in producing dwarf apples and pears by using as stock the Juneberry *Amelanchier vulgaris Moench.*

In addition, the experiment has been made of budding young hybrid pear and apple seedlings on seedlings of *Sorbus melanocarpa Neynhold* $\times$ *S. aucuparia L.*, which have a bushlike form of growth no taller than two metres.

And, lastly, we have obtained a new northern Paradise variety of undoubted complete hardiness; it was bred by crossing *Pyrus Malus paradisiaca L.* with the low-growing *Pyrus prunifolia W.*

Experiments in grafting cultivated apple varieties on this stock have yielded quite acceptable results.

PHOTOPERIODISM

Photoperiodism is a powerful factor in advancing the cultivation of subtropical species of perennial fruit trees northward.

Only in 1930, after the publication of the work of Garner and Allard on the importance of the length of sun illumination to plants, was the experimental study begun of this extremely important factor influencing the life of plants, as is vividly demonstrated in the recent work of Comrade Lysenko on the cultivation of cereal crops.

In 1932, photoperiodism proved to be extremely useful in the production of new varieties of fruiters, because of the possibility of shortening with its help the vegetation period of certain species of plants, this resulting in fuller maturation of the summer growth of the branches, which, in its turn, considerably enhances the resistance of these plants to winter cold.

Of course, the influence of photoperiodism on annual field crops differs considerably from its effect on perennial fruit plants. In the former case, its influence is limited to certain alterations in the details of growth of the plants in the year of its employment, and needs to be repeated annually. In the latter case—the case of perennial hybrid fruit plants—shortening of the vegetation period may be fixed all through the life of the hybrid variety, provided that photoperiodism was employed for several years in succession be-

powerful influence both in grafting and in propagation by cuttings, in view of the diversity of properties between different plants, however closely akin, and even between different parts of the same plant (cuttings, portions of them and even individual buds). The specimens less suited to vegetative propagation perished, while those better fitted and accustomed to it survived and multiplied.

ginning with the moment of the hybrid shoot's germination. This may be quite feasible, because all hybrid seedlings, and especially hybrids, the habitat of whose parents, i. e., father and mother, were geographically far apart, at the time of their development from the seed and in the earliest period of their life possess the faculty of vigorously adapting themselves to environmental conditions, and correspondingly build up a constitution adapted to the shorter vegetative period. This latter property is fairly satisfactorily retained later if propagation is performed vegetatively, by graftage or layerage, but is not fully transmitted if propagation is performed sexually (from seed).

Example: A hybrid peach seedling fertilized with pollen from Posrednik (*Amygdalus nana mongolica* $\times$ *Pr. Davidiana Franch.*), when the day was shortened to twelve hours, shortened its vegetation period by a whole month.

INFLUENCE OF ECOLOGICAL FACTORS ON THE DEVELOPING STRUCTURE OF ONE-YEAR-OLD HYBRIDS

In certain unfavourable years in respect to the sum-total of harmful environmental factors which (because of insufficient study of the nature of many of them) still cannot be eliminated, or changed, or ameliorated, the constitution of that year's seedlings of fruit plants irresistibly deviates towards the wild forms, or rather, towards various defects as regards culture qualities. In such years the work of the hybridizer on some species of plants is entirely wasted. Not only do the seedlings run wild; sometimes they all fail to grow and remain in a dwarfed condition, with only three to five leaves, throughout the vegetation period of that year and the years following. Furthermore, favourable years for development occur very rarely with hybrids of certain species of fruit trees. For example, crosses of the mountain ash with pear and apple did not yield successful results for seven years in succession, and only in the eighth year did the crossings succeed—every one of them—and yielded hybrid seedlings fully fitted for healthy development and growth.

ATTEMPTS TO ACCELERATE THE ONSET OF BEARING IN HYBRID SEEDLINGS OF FRUIT TREES

In the beginning of the third part of this book,[1] and many times earlier, I have referred to the erroneous method of attempting to accelerate bearing in hybrid seedlings by grafting them as cuttings onto the crowns of adult tree stocks.

One is positively astonished at the persistence of this view. It springs from ignorance of the most elementary truths of biology, one of which is that the leaves of every plant transform the raw material supplied by the root sys-

[1] The reference here is to I. V. Michurin's *Results of Sixty Years' Work*, published in 1934.—*Ed.*

tem into that particular composition from which the structure of the given plant is built up.

Take, for example, the origin of the Kandil-Kitaika apple, the hybrid seedlings of which proved to be insufficiently resistant to frost. In order to enhance hardiness, a cutting of a two-year-old hybrid was grafted onto the crown of the mother plant- -a cultivated Kitaika which was already bearing. The result was that the graft began to bear fruit several years later, i.e., at the same time as the hybrid growing on its own roots. Furthermore, the fruits on the graft were no larger than those of the ordinary Kitaika. Only in the course of time, as the branches of the Kitaika were partly removed every year, consequently reducing the influence of the work of its leaves, and as the leaf system of the graft itself increased, did the fruits on the graft gradually grow in dimensions and in the end assumed the form and size of Sinaps generally.

There have been any number of such hybrids in my many years' practice, and every time the results observed were the same. Never was the beginning of bearing accelerated; on the contrary, it was delayed, and, in the second place, a substantial deterioration of the quality of the fruits was observed, in spite of the fact that cultivated, not wild varieties of trees were taken as the stock.

It will thus be clearly seen from what has been said how utterly futile is the method of grafting cuttings of young apple hybrids, the constitution of which is still incapable of contending with the influence of the leaf crown of the stock. But, it should be remarked, if we do not allow the influence of the leaves of the stock to develop by removing all the ungrafted[1] branches from the crown of the stock, leaving only the stem for a cleft graft, for instance, or if not one cutting is grafted, but as many as possible on the main branches of the crown, then, it goes without saying, the picture will be different and the results better. Nevertheless, a grafted hybrid variety when on its own roots is sometimes of far better quality, and more effectively retains the better culture properties.

This method often has to be resorted to when the structure of the hybrid's root system happens to be poor. This was observed, for example, in the case of a new variety of the attar rose Slava Sveta. The hybrid seedlings obtained from fertilizing the yellow Persian rose with the pollen of the Damask rose rapidly perished, even before they attained a height of 5 cm., owing to the poor development of the root system.

These seedlings were saved only by grafting them on one-year-old seedlings of the *Rosa canina*. But owing to the influence of the stock the flowers of the new variety completely lost their yellow colour. The same thing happened with the Krasa Severa cherry.

[1] But this method sometimes results in killing all the parts of the stock, due to the disturbed equilibrium between the strong root system and the small amount of leafage, as a result of which, the first winter frost strikes both the roots and the stem of the stock at a time when they are filled with superfluous sap which the leaves have not yet managed to process, and the stock completely perishes.

APPEARANCE OF GYNANDROMORPHISM IN A CROSS BETWEEN A PEACH (*PRUNUS PERSICA SIEB. ET ZUCC.*) WITH THE ALMOND POSREDNIK (*AMYGDALUS NANA MONGOLICA* × PRUNUS *DAVIDIANA FRANCH*)

In 1931 flowers of the Iron Kanzler peach were pollinated with the pollen of a Posrednik almond. The fruit that set was of an extremely original form: Half of the pericarp was, both in size and in flavour of the flesh, identical with the peach; the other half was half the size of the former and resembled in everything an almond; the flesh was of a bitterish flavour, like the almond.

When the fruit, after it had been removed from the tree, was opened, the walls of the stone inside proved to be divided into several parts, and at a slight touch it broke up into those parts, as may be distinctly seen on the coloured plate.

Inside the stone there was a healthy and well-filled kernel. It was immediately planted into a flower pot, where it germinated under the constant application of ionization and photoperiodism of a 12-hour day. In the spring of the next year, 1932, the seedling was planted together with the clod of earth into a bed in the ground.

As in 1932, photoperiodism continued to be applied to the hybrid seedling in 1933 and 1934, and as a result its vegetation period of growth was reduced by a whole month.

The seedling stood well the winters of 1932/33 and 1933/34, and is still developing quite normally. We are looking forward with great interest to the first fruiting of this hybrid seedling.

THE DANGER TO OUR HORTICULTURE FROM IMPORTING AMERICAN PLANTS

It is generally known that the ordinary European varieties of apples, pears, plums and cherries are not cultivated in Japan, due to its unsuitable insular climatic conditions. Even the local Japanese varieties of these plants yield fruits of very poor flavour there. Moreover, the country teems with countless varieties of parasitic fungi, the result, apparently, of the constant violent motion of the moist surrounding air. These parasites have recently made their way to our Far Eastern Territory, where we are beginning to observe the rapid spread of the disease afflicting fruit plants known as fire-blight (caused by the fungus *Bacillus amylovorus* and *Namonia pyrivorella Morzum*). As for the United States of America, it has long been so overrun with all kinds of parasitic fungi and various other plant pests that our horticulture is really being endangered by the import of plant varieties and seeds from America. We risk contaminating our orchards with many pests, as in the case of mildew (*Sphaerotheca Mors-uvae*) which affected all our goose-

Table I. A striking case of the appearance of xenia in an apricot hybrid which was fertilized by a pollen of the almond Posrednik

berry varieties; as a matter of fact, fireblight has already made its appearance in several orchards. It is also in place to recall the fact of phylloxera having been imported into Europe from America. Besides, most American fruit varieties, especially the stone fruits, are unsuitable for our orchards, if only for the reason that although they grow and blossom profusely under our climatic conditions, yet they either altogether fail to set fruit, or if they do so occasionally, the fruits are small and have a tasteless pulp.

In a word, the importation from America and, particularly from Japan, of live plants and of seeds that have not been disinfected should be prohibited in view of the danger of introducing infection. Unfortunately, however, this measure will only enable us partially to prevent this plant scourge being transmitted to our orchards. However strict the quarantine we introduce, this Japanese poison will be carried over to us, if not through the medium of plants, then of the various other articles which we import from America and Japan.

MEANS OF SHORTENING THE VEGETATIVE PERIOD OF NEW PLANT VARIETIES

The ten new hybrid varieties of hardy grape—which stand the winter without any artificial protection—that I have produced in late years make it possible to extend the zone of cultivation of the grape another five hundred kilometres northward.

Besides winter-hardiness, what is needed of the grape for the advancement of its cultivation northward is later flowering, because of the spring morning frosts, and earlier ripening of the fruit, because of the early autumn frosts. All this together presents a difficult problem, namely, how to shorten the vegetative period of the grape.

Already in the 1900's, when working on hybrid varieties of yellow cigarette tobacco, the Kommunarka early-ripening melon and hardy grape seedlings—the first to be produced in those days—I was agreeably surprised, when selecting seedlings that completed their vegetative development earlier than the others, to find that some of the seedlings that had germinated from seed later than others, namely, at about the beginning of July, managed to complete their growth and mature even earlier than those that had germinated in the middle or the beginning of May.

I made a note of this marked, and at the same time rather paradoxical, phenomenon, and in subsequent years I never failed to keep watch for similar manifestations in interspecific hybrids of other plants. It turned out that this phenomenon is in most cases to be met with in hybrids from parents whose habitats were very far apart, and that, on the contrary, it is practically never encountered in simple seedlings or in hybrids from varieties of one and the same species coming from mutually close places of origin. This, of course, could only be explained by the fact that hybrids of parents of mutually remote places of origin are always far more susceptible to alteration of their properties under the influence of the environment than are simple

seedlings or hybrids from parents whose birthplaces were not far apart. It is more difficult to find convincing reasons for the acceleration of the vegetative period in seedlings that germinate late from the seed. An exception, perhaps, is the hypothesis that the higher temperature in July, as compared with May, has an influence in accelerating cellulose-formation in the shoots. But is this so? We know that in our parts shoots from later plantings usually result in plants which mature late, or which are still completely immature by the autumn. Moreover, everyone is familiar with the influence of equal quantities of heat on northern and southern plants: to equal amounts of heat northern plants react far more quickly than southern, a fact which was noted already in the seventies of the last century by A. De Candolle. This phenomenon is very natural and does not need experimental verification—it has nothing to do with our problem. What we are speaking of now is the faster rate of cellulose formation in late, July, shoots under the influence of a greater sum-total of heat, as compared with that of earlier, May, shoots, resulting in the latter case in a slower rate of growth. Well, this accelerated building of the organism in the very earliest stage of development of hybrids obtained from parent plants of mutually remote places of origin, sometimes becomes fixed and remains unaltered throughout the subsequent life of the plants. In this way varieties of plants are obtained with a shorter vegetative period, a feature of extreme importance for the northward advancement of the cultivation of southern species, e. g., grape, apricot, peach, etc.

Let us try to analyze the problem by successively examining the whole life cycle of a plant, beginning with the earliest stages of its development. Let us start with the seed and consider what it represents. Its most essential part is the embryo of the seedling, which harbours within it the rudiments of a multitude of properties hereditarily transmitted to their offspring from the parents and their forebears, and, secondly, the cotyledons, which consist of a stock of nourishing substances needed for the initial development of the shoot and its radicle. The composition of this stock is not a dominating factor, as is shown by the experiment of removing the cotyledons and grafting those of a different seed in their place.

As to the large number of properties hereditarily transmitted to the embryo by the parents, only a few of them, as I have said before, will develop in one degree or another, those, namely, to which the environmental conditions of the given period of the year are favourable. Furthermore, some of the properties which under the influence of the environment acquire the ability to develop, more or less undergo alteration, while from the totality of the interaction of others, absolutely new properties result, properties not possessed by the parents, as can be seen in the given case. It is because of this process that mutational deviations are manifested more strongly in the early period of development of the plant organism, and more feebly in the later stages. Shortening of the vegetative period in some hybrid seedlings that germinated late from the seed must be regarded as one of these mutational deviations.

Further work in this direction will show whether this is so or not. The essentially important thing for us is that this phenomenon provides a base for the creation of many species of plants with a shortened vegetative period. The absence of such species of plants in the past made it impossible to introduce for commercial cultivation in the central regions and the north of Russia many southern plants with a long vegetative period. One of these southern plants is the grape. The new, precocious varieties of grape do not suffer from the winter frosts, it is true, but late spring morning frosts may kill their blossoms, and, moreover, the early frosts, which in the northerly regions sometimes occur at the end of August, likewise do not spare the fruit of the grape. What we need are hardy varieties which begin to vegetate late, to blossom late, and to ripen early.

For the solution of this problem we, in our nursery, have planted for the spring and summer of 1935 seeds of new varieties of hardy grape which needs no protection against winter frosts and which ripens early. These seeds were taken from the first fruits of the new varieties, which were completely isolated from the chance pollen of any late-ripening cultivated varieties. Seedlings obtained from the seeds of a new variety of plant at the time of its first bearing are most amenable to alteration. The last two conditions are of immense importance. The shoots from such seeds should be pricked out from the boxes and planted in the beds in rows in strict succession as they germinate, thus artificially helping to lengthen the period between the early ones and late ones. In the autumn, selection should be made by picking out the seedlings, wood formation along the vines of which has reached the greatest height. The results of the experiment should then be assessed. In this way we shall obtain already in this first generation a sufficient deviation towards later beginning of growth in the spring and earlier termination of growth in the autumn.

It should furthermore not be forgotten to terminate growth artificially at the end of the summer (beginning with August 25) by nipping off the ends and the spurs of the vine.

When selecting one- and two-year-old hybrid and simple seedlings according to habit, it should be borne in mind that in the case of the grape, as of all species of plants at a young age in general, the constitution of all parts of the organism in its infancy has an inherent tendency to deviate towards the form of the wild progenitors.

This deviation is one of the manifestations of the so-called biogenetic law, according to which every organism in its embryonic and infant development repeats all the alterations of form through which its race had passed.

When selecting seedlings, those with the shortest vegetative period should be considered the best. From these seedlings a selection should be made according to sturdiness of development, thickness and length of the vines, and largeness of the leaf laminae, and also, of course, according to frost-hardiness and immunity to disease and parasites. Later, at the time of the

first bearing, selection should be made according to yield and the taste and external qualities of the fruits.

When selecting seedlings it should be remembered that not only in some hybrids, but also in pure species of grape, sometimes as many as sixty per cent of the seedlings develop into staminate plants. Such seedlings should be destroyed, since they cannot bear fruit.

COVERING THE SOIL UNDER PLANTS

I have long observed that if the soil under plants, after having been thoroughly loosened, is covered in spring and summer, and especially in dry years, with leaves, straw, moss or other, more compact, material, the plants develop nearly twice as fast and better than those where the soil is not covered. All this has been fully confirmed by recent work of foreign horticulturists.

In North America, for example, good results are being obtained by covering the soil with thin cardboard impregnated with asphalt, which they call thermogen. Large apertures are made in the thermogen at considerable distances from one another to permit free access of air and rain water, as well as apertures for the plants. Soil of crumbly structure facilitates penetration of air, thus promoting the bacteriological processes which enrich the soil with various nutritious substances. When the soil is covered, these processes proceed more intensely; moreover, moisture is better preserved, the soil does not get so heated from the sun's rays, and is protected from sharp falls of temperature.

SELECTION OF HYBRID SEEDLINGS

Selection of seedlings for hardiness should not be made from one-year-old individuals, since at this age growth development depends on the time of germination of the seed, which may sometimes be half a month or more later than the initiation of growth in adult plants of the same species; as a result in the first year the wood of the seedlings in most cases fails to mature well by the autumn. Different is the case when selection is made from two-year-old seedlings or from one-year-old grafts, the plants having been able in the summer of the second year to make use of the full vegetation period. In this case error in the selection of the more frost-hardy is precluded. But even when selecting seedlings for hardiness at the end of their second year, consideration must be given to whether the summer was not unusually humid, or whether there were not unusually severe frosts in the winter (such as, for instance, in the winter of 1928/29). In such cases strictness in roguing the seedlings should be somewhat relaxed.

TRAINING HYBRID SEEDLINGS OF THE SECOND GENERATION

Seedlings of the second generation of new hybrid varieties of apples and pears, obtained as the result of fertilization with the pollen of the same varieties or the pollen of local old varieties, will in their overwhelming majority inevitably produce varieties inferior both as regards flavour and the time of early summer maturation. This is a consequence of the repeated influence of the climatic conditions in our section of the country and of the influence of our local varieties in the role of fertilizers. The originator who works with fruit varieties of apples and pears should therefore always give preference to the planting of first-generation hybrids. Where good local winter varieties of fruit trees exist under local climatic conditions, as, for example, on the South Crimea coast, in France, Belgium, South Germany and "Burbank's" California, it is quite in place to train the second generation, and the results should be good. But this should not be done in our parts, under our severe climatic conditions, whose repeated influence has a deteriorating effect on the structure of the seeds and seedlings.

INHERITANCE OF ACQUIRED CHARACTERS

Even before the beginning of the present century all naturalists were very much interested in solving the question as to whether acquired characters are transmitted by inheritance or not. In studying this question scientists divided into two camps, one of which used every kind of argument to refute this possibility, while the other recognized that such transmission by inheritance must actually exist, arguing that without this there could be no evolutionary movement in the structure of living organisms.

The controversy on this question remains unsettled to this day. With us fruit growers our entire case is usually based on the propagation of new hybrid varieties by the vegetative method of grafting or cutting. And even if partial changes do occur in the propagated varieties of plants they are so insignificant that ordinarily they are not even noticed. It will be a different matter should we decide by the vegetative method to propagate these hybrid varieties in their youth, when they have not as yet developed stability. In such cases we will, as in cases of sexual propagation, inevitably meet with the following phenomenon: the varieties may apparently lose or change their properties and acquire absolutely new characters as a result of the influence of external factors.

But all this, nevertheless, cannot induce one to agree with Spencer's extremely erroneous postulate that either there has been inheritance of acquired characters, or there has been no evolution. I would say that properties acquired hereditarily by hybrids are, as a matter of fact, not lost when these hybrids are propagated sexually (by seeds) in the second generation; what actually takes place is a change in the type of their combination, some

of these properties remaining latent,[1] while others, grouping themselves with the hybrid's formerly latent but now emerging properties, become dominant in the types of grouping that vary for every separate seedling.[2] Hence, the conception of short- and long-lived modifications is in the given instance entirely irrelevant, for between the false notion that acquired properties completely disappear and the notion that they exist latently in the progeny, lies too wide a gap; and everywhere the visible evolutionary change of the forms of living organisms, caused by the inheritance of acquired characters, is so obvious that it definitely removes all doubts in this respect. Thus, the changes in the combinations of the properties of plants do not in the least hinder the evolutionary change of the forms of living organisms.

All the distinctive characters of any variety of fruit plant are a result of hereditary transmission and a combination of the influences of external factors,[3] *both in the embryonic period of the formation of the seed and in the postembryonic period of the development of the seedling from the seed.* But since, as time passes, these combinations of the different external factors constantly change, and since we cannot at will create anew exactly the same groups of external factors that existed when the variety was obtained, we shall, in planting the seed of the hybrid, never secure the same variety but always a completely new one. These new varieties will only possess a residue of the properties of the former ones, properties that were preserved because they were in the organism of the plant itself, in the sex cells and did not originate from the external influence of the environment. But even these latter are frequently absent in the progeny of interspecific hybrids. As an example let us take the seedlings of the interspecific hybrid Krasa Severa cherry, a product of the cross between the sweet and the sour cherry. Among these seedlings there is never a single specimen possessing the pure specific characters of the sweet cherry. All of them, after many plantings over a period of forty years now, are entirely new varieties of cherry that always differ from one another, with a predominating tendency towards the structure of the maternal parent, i.e., the sour cherry, but with a more luxuriant development of all parts of the organism. And this manifests itself particularly fully if the maternal plant was not own-rooted, but was grafted on the stock of ordinary cherry seedlings. If, however, the tree was own-rooted or was grafted on the seedlings of cultivated varieties of the sweet cherry, then the seedlings of the hybrids manifest a more luxuriant structure. Nevertheless, there will not be found among them an individual with marked characters of the sweet cherry.

[1] It sometimes happens that latent properties which do not for a long time meet in the outside environment with conditions favourable for their development, gradually weaken and are destroyed altogether.

[2] Besides, these new combinations of the hybrids' former properties are sometimes distributed in every part of the organism of each hybrid seedling not evenly but in various forms of build, hence the appearance of sport variations.

[3] Plus the correlative influence due to the mutual influence of one on the other

CULTURE OF SUBTROPICAL PLANTS

I am not sufficiently acquainted with the local conditions of culture and the peculiar properties of subtropical plant species, particularly citrus (and with their parthenogenesis); owing to this there may be some errors in my judgments. Nevertheless, since I should like to render plant breeders in the subtropical sections of our country all the assistance I can, I offer, on the basis of my many years of work and experiments, the conclusions I have arrived at with regard to the main task—that of increasing the frost-hardiness of subtropical species of economic plants in general and, particularly, of citrus fruits, the tea tree, the cork-oak and other species of economic value. It must be said that, in view of the structure of the leaf system in all species of plants with evergreen leaves, it is so far possible to obtain but a slight improvement in the direction of frost-hardiness. Nevertheless, it is a possibility which should be made the most of. By training two or three generations of hybrid seedlings it is quite possible gradually to obtain frost-hardy forms of subtropical crops by employing the only correct method, which consists in the breeding and strict selection of new exclusively hybrid varieties trained by bringing the action of photoperiodism to bear upon them from the earliest stage of the development of their organism from the seed. Here a more detailed explanation of the method I recommend is needed.

First of all it is necessary firmly to remember the following.

1. All hybrid seedlings which have come from crosses between parent plants (father and mother) distant from each other as regards their geographical habitat, are, from the earliest stage of their development from the seed, particularly until they reach the age of five years, endowed in an exceptionally strong degree with the property of adapting themselves to all the ecological conditions of the locality where they are growing and under the influence of which they are building up their organism. Therefore all the alterations they acquire at this early age are retained in their entirety, without changing, in their subsequent life—something which never occurs in old varieties, where the alterations are temporary and gradually disappear in the years immediately following. It follows from the above that if by applying photoperiodism in the earliest stage of the development of hybrid seedlings, even if only in the course of three years, we shorten their vegetation period and thereby make them more resistant to frost, this property will become permanently fixed in them. This will occur because of the fact that the very structure of each hybrid seedling will—to some or other extent—present various deviations from the usual structure of the old varieties, and this will make it possible to select specimens of seedlings with more useful properties both as regards frost resistance and as regards superior quality of fruits, etc. Such selected individuals of first-generation seedlings should be employed in the second generation already in the role of male or female parents for the production of hybrids with still better and more useful deviations. By following this procedure we should have long since created new

varieties of various species of plants in the subtropical sections of our country.

2. To obtain first-generation seedlings for training, five or six combinations of parent pairs should be properly selected and the seed obtained from the cross of each separate pair of parents should be planted into a row, care being taken, under *all* circumstances, that their germination and sprouting should occur when it is already warm, when there is no longer any danger of morning frosts. The observance of this condition is of major importance. The point is that the shoots of seeds which germinated in a warm period develop at an accelerated rate, whereas those that germinated in a cold, early spring grow at a slow rate. In the subsequent life of the seedling this function of late spring vegetation sometimes becomes a permanent property, which is very beneficial, because thereby the danger of the young growth being injured by early morning frosts is avoided, and, besides, a strain with early ripening of fruits is obtained as the result of the subsequent accelerated rate of development of all the details of the hybrid.

In choosing combinations of plant pairs for crossing, the role of the female parent should be assigned to individuals with relatively better qualities, because the maternal plant always more fully transmits its properties by heredity to the hybrid.

3. In the first and second years after germination from the seed, seedlings should be trained in meagre soil and, without fail, in a place well protected from winds. Otherwise the young hybrids, with their small foliage, will not be in a position fully to utilize the carbon dioxide of the air, because the gas will be blown away by the wind from the surface of the soil. As a result the constitution of their organism will sharply deviate towards the side of wild forms. Superfluous moisture in the soil should be avoided. Nor should the development of group growth of several shoots from the root neck be permitted; side branchings from the main shoot should be left in a limited quantity, so that they may better develop in thickness, which helps to increase the size of the fruits of hybrid seedlings.

First published in 1934 in
I. V. Michurin, *Results of Sixty Years' Work*

PROCESS OF BREEDING AND POMOLOGICAL DESCRIPTION OF MICHURIN VARIETIES

APPLES

SIX-HUNDRED-GRAM ANTONOVKA

This strain appeared in 1888 as a "sport" (a bud variation) on a branch of a five-year-old sapling of the well-known old Antonovka variety—Moghilyovskaya Belaya. In 1892, after many tests over a period of four years, I put it on sale, as its fruits were of an exceptionally large size and of good quality.

Fig. 63. Cross section of a 600-gram Antonovka (drawing by I. V. Michurin)

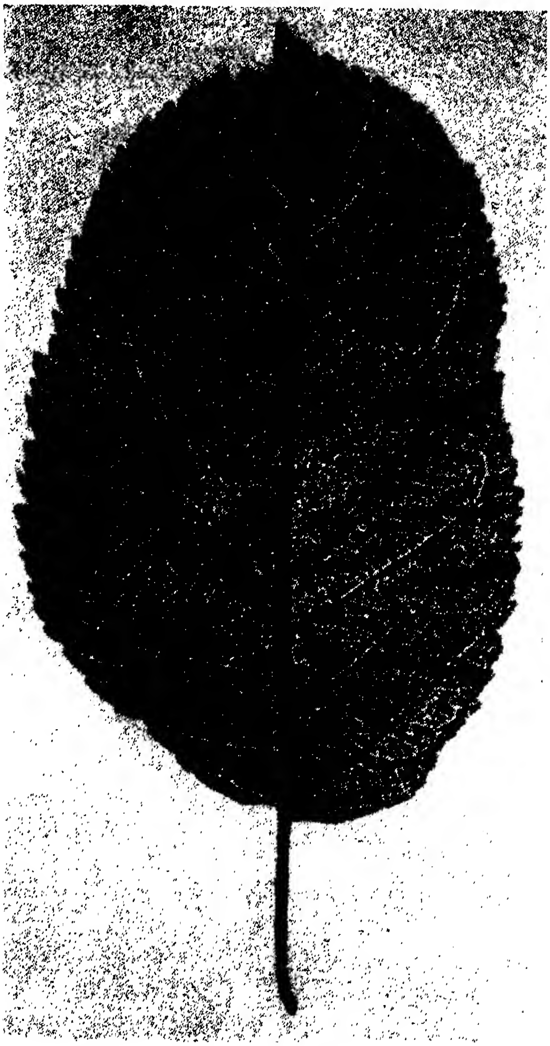


Fig. 64. Leaf of a 600-gram Antonovka

It should be noted here that every sporting deviation requires, for the preservation of its qualities and, particularly, the size of the fruits, special methods of propagation. They consist in the following. When cuttings are taken for budding, only double shoots, grown together, should be selected; otherwise, if shoots of the ordinary form are used as cuttings, the saplings will yield fruits of varying size, mainly medium-sized. There are usually from five to ten such double shoots on an adult tree. Further preference should be given to double buds, situated close to each other. Seedlings of cultivated kinds, particularly Skrizhapel and its varieties, are preferable as stock.

Shape of fruit: bulbous oval, slightly ribbed.

Colouring: white, with white dots beneath the rind, very pretty.

Size: length 98 mm., diameter 125 mm., weight 608 gr.

Stem: short, placed in a deep cavity covered with rust.

Calyx: closed, situated in a ribbed basin.

Core: broad, with closed carpels.

Seeds: medium size, pointed towards the top, full, dark brown.

Flesh: white, juicy, fine-grained, sweet to the taste, with a mellow acidity and delicate fragrance.

Ripening time: usually September-December, but in some places, depending on the soil, the fruits can be preserved even until March without losing their beauty or flavour.

Properties of tree: complete hardiness, strong growth, thick shoots, broad-shaped leaf blade, and abundant fertility.

An excellent variety, particularly for the production of paste and other preserves.

On account of the beautiful display its fruits make, the strain is particularly suited for the orchards close to large industrial urban centres.

Owing to their big size and loose structure of the flesh, the fruits require careful packing.

1929

ANTONOVKA SHAFRANNAYA

Obtained from seed of a common Antonovka fertilized with the pollen of a Reinette d'Orléans. The cross was made with the aim of improving the

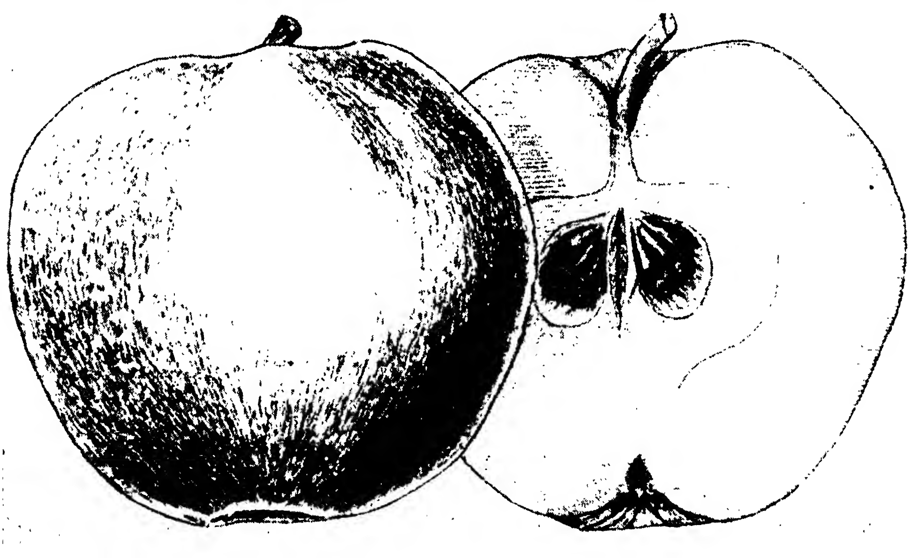


Fig. 65. Fruit of Antonovka Shafrannaya (seventh year of bearing, 1915). (Drawing by I. V. Michurin)

flavour of the Antonovka and enhancing the capacity of its fruits to keep fresh for a long time in winter storage. The seed obtained from the cross germinated in 1902.

The tree first bore fruit in 1909, the eighth year of growth.

Fig. 66. Leaf of Antonovka Shafrannaya

Shape of fruit: oval-conical, narrowing towards the calyx more than towards the stem (see Fig. [65]).

Colouring: the rind is glossy, compact, sometimes covered with a quaint lacy network of rust; when just picked, the fruits are yellowish-green; in

storage they assume a pleasant yellow colouring with a reddish tint on the sunny side, with stripes and lines of a brown-carmine colour.

Size: length 68 mm., diameter 77 mm., weight 172 gr.

Stem: thick, short, slightly protruding from a deep, narrow cavity.

Calyx: broad, closed, situated in a fairly deep basin.

Core: with closed carpels containing from 15 to 22 seeds.

Seeds: full, sharp-pointed; on drying assume a greyish-brown shade.

Flesh: pale yellow, juicy-crunchy, spicy, of a sour-sweet fragrant winy flavour.

Ripening time: the fruits of Antonovka Shafrannaya have outstanding storage qualities; they keep fresh until May, without losing their succulence; ripening begins in storage, in January.

Properties of tree: fairly thick shoots; not exacting as regards soil; is distinguished by hardiness; fertility abundant and regular.

The blossoms have an increased number of pistils with a large quantity of vigorously acting pollen; fertilizes well with own pollen and requires no cross-pollination with other strains, wherefore the trees are suitable for solid plantations.

A third-grade variety.

Described in fuller detail in the magazine *Progressivnoye Sadovodstvo i Ogorodnichestvo,* No. 23, for 1914.

1929

BELLEFLEUR-KITAIKA

Bellefleur-Kitaika is a hybrid of American Yellow Bellefleur fertilized with the pollen of a Kitaika in order to enhance the hardiness of the Yellow Bellefleur in the severe climate of our regions.

The seed sprouted in 1908. The seedling first bore fruit in 1914, the seventh year of its growth.

The size of the fruits in the first fruiting year was: length 75 mm., diameter 80 mm., weight 154 gr. They ripened between August 17 and 23.

From the spring of the second fruiting year, cuttings of a real Yellow Bellefleur were whipgrafted on the branches of the hybrid tree to serve as mentor, in order to develop the ability for later ripening of the fruits. As the result of the action of the mentor, the fruits increased in size and weight, and the ripening was retarded for more than a week, while the ability to keep fresh in storage extended for full six weeks.

The fruits in that second year of fruiting, in 1915, were 85 mm. long, 85 mm. in diameter and weighed 201 gr. They ripened between August 23 and September 5, and remained fresh until October 9.

Their colouring was a yellow-golden background almost all covered with a beautiful bright-red tint crisscrossed with lines and dotted with specks.

The flesh was snow white, of a piquant, spicy, winy-sweet flavour with a slight pleasant acidity and a strong fragrance.

In 1916 the weight of the fruit reached 222 grams and the storage ability extended for an additional 75 days. Thus, fruits which matured on the upper

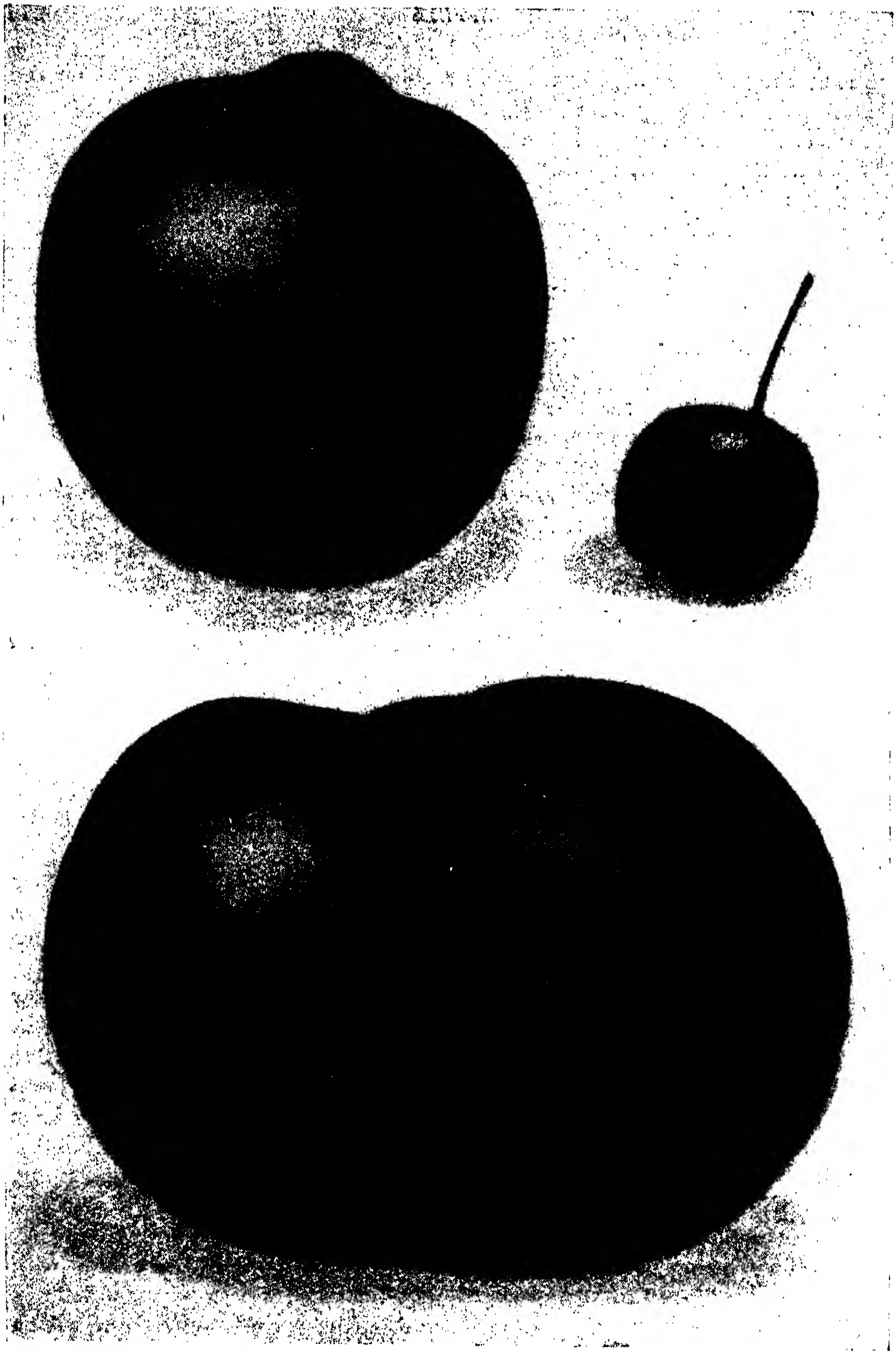


Fig. 67. Upper left—Yellow Bellefleur; upper right—Kitaika (*Pyrus prunifolia*); below—Bellefleur-Kitaika hybrid

branches of the tree were fully ripe in October, and the fruits from the lower branches kept fresh until December 25, despite the fact that, owing to the very rainy second half of the summer and autumn, the fruits grew juicy and some of them became transparent.

The development of the capacity of the fruits to keep fresh for a lengthy period was in this case due to the influence of the mentor, grafted in the spring of 1915, and of six more cuttings of winter strains of apples, among

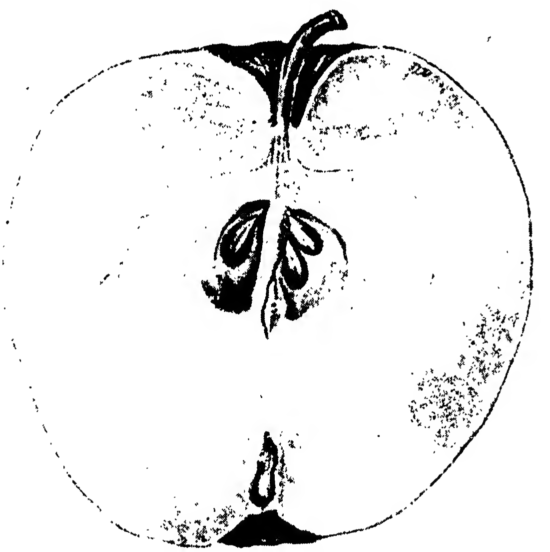


Fig. 68. Cross section of fruit of Bellefleur-Kitaika

them four cuttings of the well-known Napoleon variety, grafted in the spring of 1916. All the grafts were inserted only on the lower branches. In 1919 a Bellefleur-Kitaika was grafted on the branches of an adult, 20-year-old tree of a 600-gram Antonovka.

On this tree the Bellefleur-Kitaika first bore fruit in 1921.

In 1923, 1924, 1925 and 1926 the yield was extremely generous, the size of the fruits increased considerably, while the flavour remained absolutely unchanged.

From this experiment I draw the following deductions: first, that, despite the prevalence of foliage, the new strain, 600-gram Antonovka, in the first years after it had been engrafted with another strain, not only exerted no harmful influence upon the latter strain, but even noticeably improved the size of its fruits.

Secondly, it becomes obvious from this experiment that Bellefleur-Kitaika, as a new variety, has managed to develop complete stability and will no longer

submit to the vegetative influence of stocks, particularly if the latter are not wilding-seedlings of some excessively small species, like the dwarf variety of Siberian apple, and if they are young—not over two or three years.

Here, now, is a pomological description of Bellefleur-Kitaika.

Shape of fruit: roundish-oval, slightly ribbed.

Colouring: golden-light-yellow background, overspread with a delicate reddish tint, with lines and specks of a soft and deep bright-red colour.

Fig. 69. Leaf of Bellefleur-Kitaika

Size: length 85 mm., dianreter 100 mm., weight 340 gr.

Stem: thick, short, 8 mm. long; all sunk in a deep cavity.

Calyx: closed, situated in a deep ribbed basin.

Core: small, with closed carpels, with whitish curved protuberances on the partitions between them.

Seeds: very large, with a longitudinal projection.

Flesh: snow white in colour, of a delicate fine-grained texture, piquant-spicy flavour with a slight, pleasantly refreshing acidity and a strong fragrance. For its beauty and flavour the Bellefleur-Kitaika is certainly not in the least inferior to the maternal plant—American Yellow Bellefleur.

Table II. Bellefleur-Kitaika with parent plants:
right—Bellefleur-Kitaika; lower left—Kitaika (father); upper left—American Yellow Bellefleur (mother)

Ripening time: from September to January. Under good storage conditions the fruits can remain fresh until February, without losing any of their excellent savoury qualities.

Properties of tree: characterized by luxuriant growth, thick shoots, complete frost-hardiness of all parts; its large leaf blades exceed in size the leaves of the maternal parent, i.e., of the American Bellefleur.

The blossoms possess outstanding resistance to morning frosts in the spring. Seedlings from Bellefleur-Kitaika seeds are almost all distinguished by their good structure. It is the best strain for the role of maternal parent in hybridization.

I consider it pertinent to note also a special property of the root system—the ability to endure with amazing ease, without the least sign of suffering, the transplantation of the tree to a new place. In all the many years of my work with various apple seedlings I have never come across such a property in any other variety.

This variety, Bellefleur-Kitaika, proved quite frost-hardy in the Ivanovo Region at 58° N.Lat., five hundred kilometres north of the town of Michurinsk. It was grown by Citizen N. Dianov.

It is a first-rate variety in all respects, deserving to be grown most widely on a commercial scale.

1929

BELLEFLEUR KRASNY

In order to obtain a strain of apple with flesh of an original and striking red colouring, a blossom of Bellefleur-Kitaika was fertilized with the pollen of the hybrid called Yakhontovoye (a cross of a Niedzwetzkyana apple with a common Antonovka). This was done in 1914.

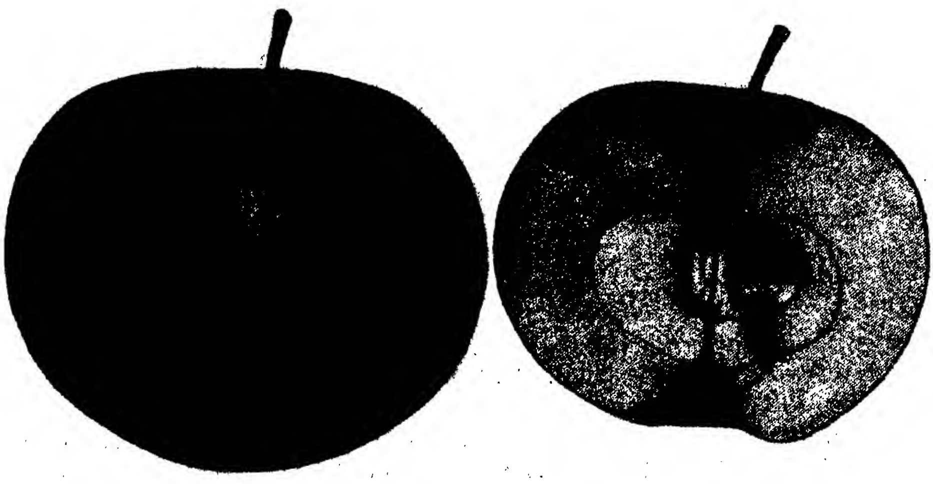


Fig. 70. Fruit of Bellefleur Krasny

The seed obtained from the cross sprouted in 1915.

The first fruit, after a grafting on the branches of a Niedzwetzkyana hybrid sapling, was produced in 1924, i.e., on the tenth year of growth.

Owing to the double influence—that of the crossing and the vegetative influence of the adult stock on the young (two-year-old) scion, the characters of the Niedzwetzkyana apple were strongly pronounced in the constitution of the new strain.

They were expressed in the reddish colouring of the leaves of the young growth, a considerably darker colouring of the rind of the fruit, its more ribbed

Fig. 71. Leaf of Bellefleur Krasny

shape, and its ability to keep fresh longer in winter storage; the flavour, however, was inferior to that of the maternal strain, i.e., of the Bellefleur-Kitaika.

But we cannot judge the quality of fruits on the basis of the evidence in the second year of fruiting, if only for the reason that in this case

the fruits of the second year were double in size and weight as compared with those produced in the first year, and their flavour too improved considerably.

Shape of fruit: turnip shape, like a Calville (see Fig. [70]).

Colouring: the rind with a general pale-lilac background, lighter on the shaded side, is nearly all crisscrossed with purplish-carmine lines.

Size: length 60 mm., diameter 80 mm., weight 158 gr.

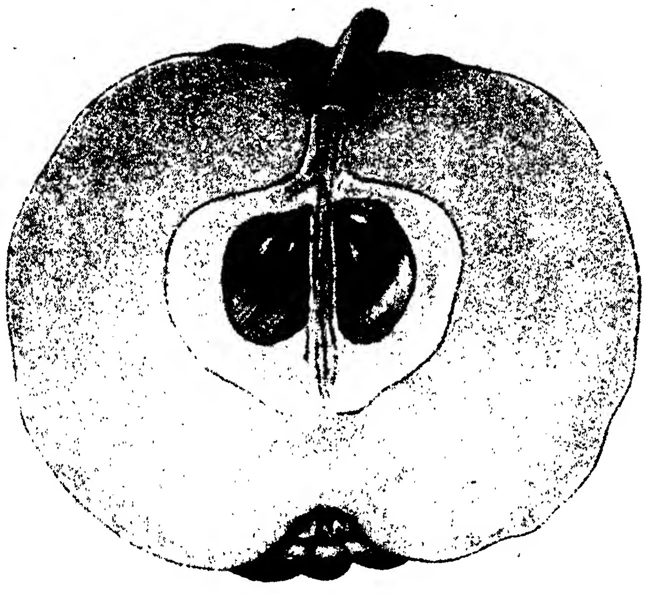


Fig. 72. Cross section of fruit of Bellefleur Krasny

In the first year of fruiting the weight of the fruits was 79 gr.

Stem: very thick, 18 mm. long, of a dark-red colour, sunk in a deep ribbed cavity.

Calyx: closed, situated in a deep ribbed basin.

Core: broad, with closed carpels.

Seeds: medium size, full, of a dark-red colour.

Flesh: juicy, loose, fine-grained; sweet, with a slight pleasant acidity; the flesh beneath the rind and the core are of a pale-pink colour.

Ripening time: February-March. They become fit for use in December.

Properties of tree: absolutely insensitive to cold; the elastic shoots hold the fruits firmly, and even strong winds and tempests do not cause windfall; good fertility. A first-rate variety.

BELLEFLEUR RECORD

Obtained from seed of Bellefleur-Kitaika fertilized in 1914 with pollen of Yakhontovoye (red-leafed hybrid of Niedzwetzkyana apple and common Antonovka).

In producing this strain I was actuated by the same aims as in the case of Bellefleur Krasny.

The seed obtained from the cross sprouted in 1915. The seedling first bore fruit in 1925, the eleventh year of its growth.

Shape of fruit: rounded-conical.

Colouring: dark carmine; on the shaded side rose-carmine; the main background covered with rather large dark-carmine spots.

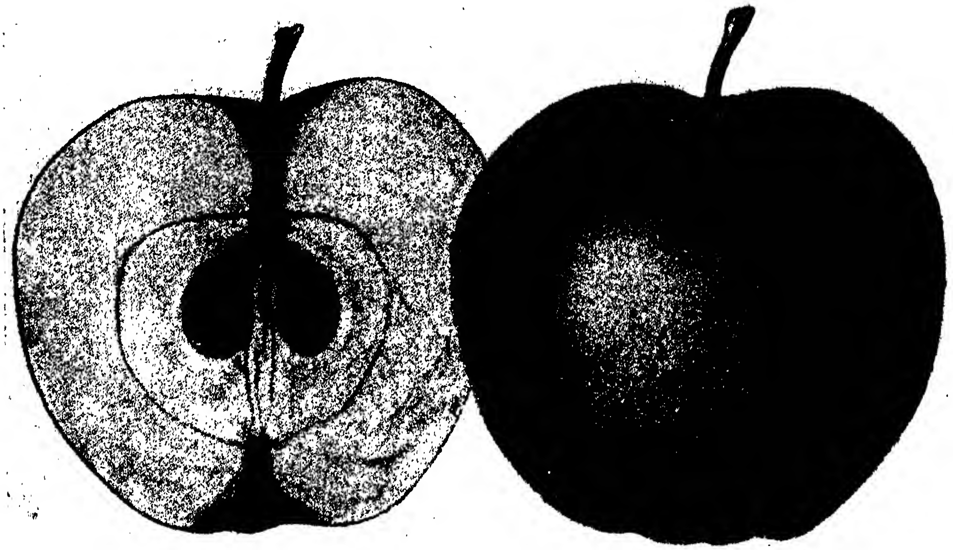


Fig. 73. Fruit of Bellefleur Record

Size: length 53 mm., diameter 71 mm., weight 123 gr.

Stem: fairly thick, 16 mm. long; sunk in a deep, rather wide, regular funnel-shaped cavity covered with a dirty-grey coating.

Calyx: half-open, situated in a rather deep ribbed basin, covered with a delicate grey down.

Core: medium size, with open carpels.

Seeds: medium size, light brown, with a reddish shade, pointed towards the end.

Flesh: white pinkish, loose, large grained, with a pleasant sourish flavour and fine fragrance.

Ripening time: February-March. Becomes fit for use in December.

Properties of tree: strong growth, healthy; twigs of medium thickness, fairly resilient, withstanding strong winds well, thanks to which there is little windfall in the summer.

The foliage is rather abundant. The tree is fully resistant to our winter cold. Fertility is good. The fruits are immune to the *Monilia fructigena* fungus.

A first-rate variety, suitable for display.

1929

MICHURIN BESSEMYANKA

Grown from a Skrizhapel seed fertilized in 1912 with pollen from Komsin Bessemyanka, with the aim of obtaining a valuable commercial variety for the central and partly the northern belt of the U.S.S.R.

The seed gave a seedling with four cotyledons in 1913.

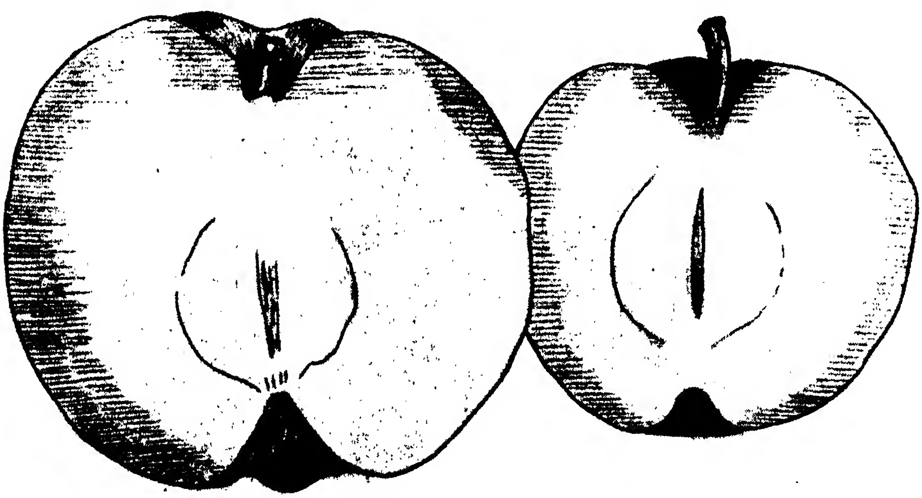


Fig. 74. Fruit of Michurin Bessemyanka (reduced, drawing by I. V. Michurin)

A graft of this seedling on the crown of an adult fruit tree first bore fruit in 1921, and the fruits did not in any way differ from those of the male parent, only they were much smaller in size.

Shape of fruit: from oblate to round (see Fig. [74]).

Colouring: yellow-light-green; sunny side covered with broad broken carmine lines.

Size: length 67 mm., diameter 72 mm., weight 185 gr.

Stem: thick, 20 mm. long, sunk in a deep, slightly ribbed cavity.

Calyx: medium size, half-open, situated in a rather deep, slightly ribbed basin.

Core: in some fruits entirely absent, in some, however, it is fully formed.

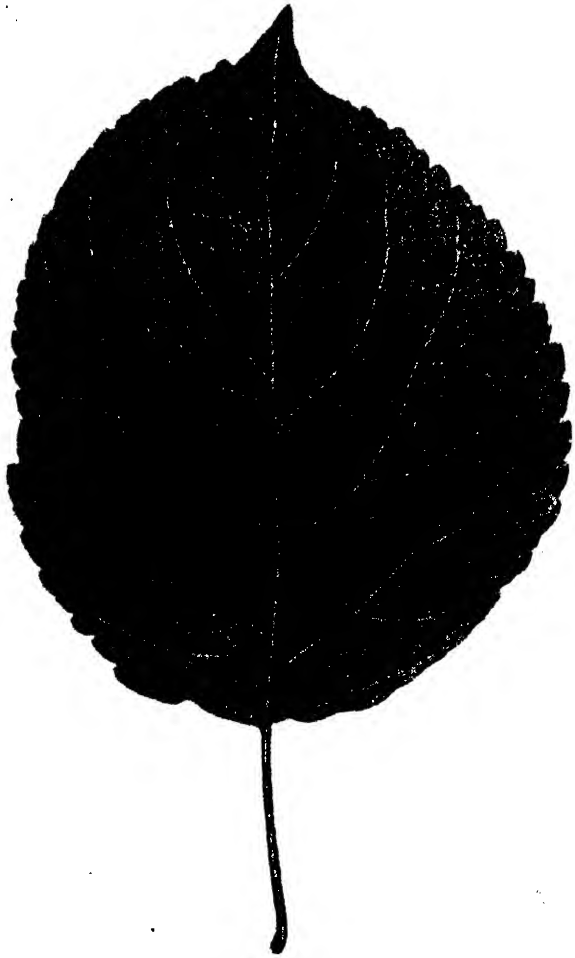


Fig. 75. Leaf of Michurin Bessemyanka

Seeds: in the majority of fruits they are absent, because this strain is not fertilized with its own pollen, but when there are nearby some apple varieties which show an affinity for fertilizing the Michurin Bessemyanka, the latter may produce seeds, though in a small number.

Flesh: juicy, solid, of an excellent winy sour-sweet flavour, with a pleasant fragrance.

Ripening time: fit for use in October; the fruits have outstanding storage qualities, keeping fresh till the next harvest without losing their external qualities or flavour.

Properties of tree: the woody tissue of the branches is firm, withstands winds and storms well. The tree is fully frost-hardy.

I consider both Komsin and winter Michurin Bessemyanka first-rate strains, suitable for commercial growing in orchards of the central and, partly, the northern belt of the U.S.S.R.

1929

BORSDORF-KITAIKA

Borsdorf-Kitaika is a hybrid of Borsdorf Bulb fertilized in 1907 with pollen of a Kitaika. The aim was to produce a new strain with extra-long storage capacity and good flavour—the qualities of the maternal plant, whose fruits,

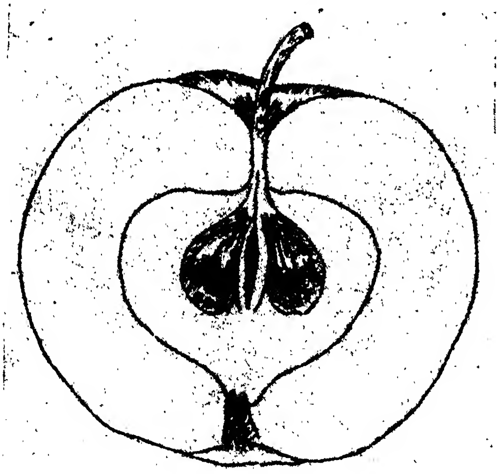


Fig. 76. Fruit of Borsdorf-Kitaika (drawing by I. V. Michurin)

when properly kept, remain fresh until the new harvest, without losing their excellent qualities, but whose tree is non-hardy in our regions. The seed obtained from the cross sprouted in 1908.

The seedling bore fruits for the first time in 1915, the eighth year of its life.

Shape of fruit: rounded turnip-like (see Fig. [76]).

Colouring: yellow green; occasionally a slight reddish tint may be noticed; the entire surface sprinkled with whitish dots under the skin. In general, the

Borsdorf-Kitaika has a very pretty and neat appearance, and, besides, the external parts of its fruits are immune to fungous spottiness.

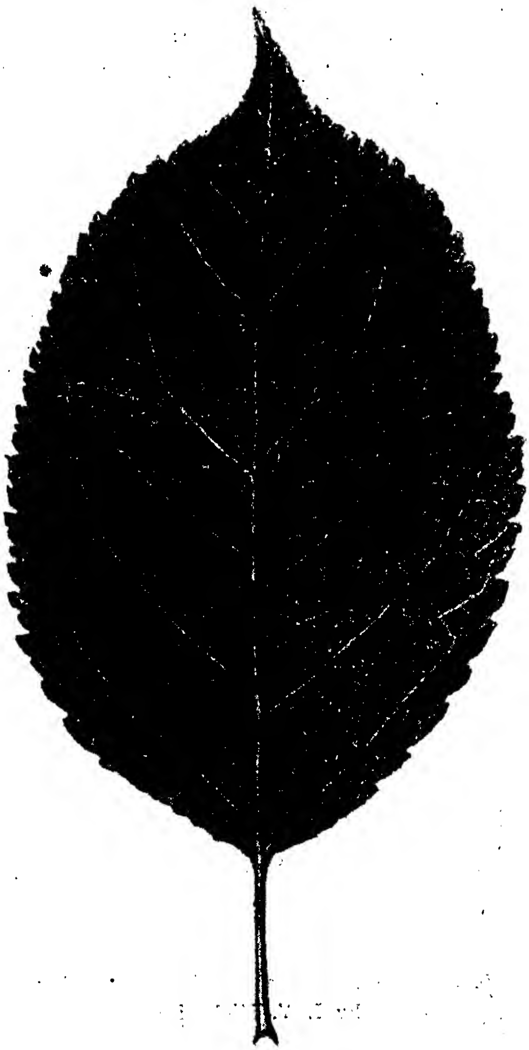


Fig. 77. Leaf of Borsdorf-Kitaika

Size: length 42 mm., diameter 51 mm., weight 55 gr.

Stem: about 14 mm. long, medium thickness, sunk in a broad and not deep cavity.

Calyx: closed, small; the basin is broad and quite shallow.

Core: medium size, greatly resembling the onion, with closed carpels.

Seeds: medium size, full, light brown.

Flesh: solid, white, of fine-grained texture, juicy, with a Reinette flavour.

Ripening time: becomes fit for use not before the second half of December; keeps fresh in storage until May.

Properties of tree: full hardiness and fairly good fertility; the fruits hold firm on the branches, are distinguished by their outward appearance and for their neatness in winter storage. Because of its storage qualities and flavour, it is an excellent, first-rate table sort.

ARKAD ZIMNY

A New Apple for the Orchards of Central Russia

Among the very good winter varieties of table apples we ought to class the hybrid I recently obtained by crossing the well-known red-leafed Niedzwetzkyana apple with our common Antonovka. From the seeds of one fruit produced by this crossing I obtained fourteen seedlings; seven of these deviated in their constitution towards the maternal parent, i.e., the Niedzwetzkyana apple, from which they inherited the red colouring of their leaves, fruits and bark of the shoots. On the other hand, the influence of the male parent, i.e., the Antonovka, was undoubtedly the determining factor in the considerably increased size of the fruits and their improved flavour. The other seven seedlings showed no signs whatever of hereditary transmission of the properties of the two parent plants; they rather resembled Caucasian or Central Asian kinds of apples, but with the flavour of their fruits considerably improved. The flavour of the fruits of one of these seedlings greatly reminded one of our sweet summer apple, a particular favourite with children, known as Arkad, but the flesh is more juicy and delicate. The shape of the fruits of this strain, which I have named Arkad Zimny, is somewhat oval, its length reaching 62 mm. It weighs from 20 to 25 zolotniks. The colouring is light yellow, with brown-red stripes and specks. The fruits excellently keep fresh throughout the winter and spring. The tree is of medium height, somewhat pyramidal in shape, is unquestionably 100% frost-hardy in our regions, and its blossoms have likewise proved to be very hardy to morning frosts in spring. In the past two years nearly all the blossoms of old cultivated apple varieties in our orchards were killed by late spring morning frosts; only the Arkad Zimny described in this article and all my new strains produced from crosses with the Kitaika escaped injury and brought in a full crop. In the description of the new strain given above we have a graphic and highly instructive example showing that hybridization may produce strains with properties which have nothing in common with the parent varieties. In this case, for instance, the maternal plant, the Niedzwetzkyana apple, is one with exceptionally pronounced properties. Its leaves, blossoms, fruits, bark, and

to some extent the wood are of a distinctly red colour. Yet in the second group of seven hybrid seedlings there is no trace of this colouring. Nor are any signs of the influence of the male parent, i.e., the Antonovka, to be noticed in them. Furthermore, these seven seedlings have nothing in common with one another. Some had turnip-shaped fruits, with a green colouring and sour flavour, the fruits of others were elongated-oval with flesh of an insipid flavour; and one, the seedling here described, yielded fruits of a particularly sweet flavour. The only thing all these seedlings had in an equal measure was the outstanding frost-hardiness of the wood and blossoms, surpassing even that of the Antonovka (to say nothing of the Niedzwetzkyana apple, which is unhardy in our parts) and also the ability of the fruits to keep fresh until summer. Further, when I planted seeds from the fruits of these seven seedlings, there occurred no segregation of parent characters, as it is called. Not one of the seedlings had any signs of red colouring in any of its parts. But what is most surprising is that there were absolutely no signs of red colouring in the seedlings obtained from the seeds taken from the fruits of the first group, the seven red-leafed hybrids. Here, apparently, the red colouring character remained in a latent state, because in my further experiments, when I used pollen from these seven red-leafed hybrids to fertilize blossoms of Pippin Shafranny and Bellefleur-Kitaika, 10% of the seedlings obtained from these crosses were half-red, while the shape of the leaves and shoots and the structure of the branches deviated towards the maternal parents used in the crossing, namely, the cultivated varieties of Pippin and Bellefleur. It has thus come to light that in these red-leafed hybrids we have fairly vigorous male parents for crosses with cultivated varieties, particularly convenient also for the reason that their influence does not paralyze the hereditary transmission of properties of the cultivated maternal strains. Besides, they are of special value to amateur hybridizers also for the reason that they provide an opportunity for extremely interesting observations of hereditary transmission of characters by the male parent to its hybrids in the earliest stage of their inception—while still in the seed, which are coloured through in different degrees of red or pink. Further, the colouring is clearly evident in the cotyledons of the sprouts and, then, on the leaves and bark of the shoots of the seedlings until their first fruiting, when it appears in the rind and flesh of the fruits. In general, I warmly recommend to amateur hybridizers and breeders of new varieties of fruit trees to start their studies with these male parents.

For the hybridization of pears, it would be good to get a strain with red-fleshed fruits. Unfortunately, I missed a chance when such a variety was listed, about twenty years ago, in a catalogue of Mr. Strus in Kiev, a fruit-growing establishment long since out of existence.

January 18, 1917

CALVILLE ANISOVY

With the aim of eliminating the susceptibility of the apple Anis Barkhatny to the "pertsovka" disease,[1] and also of imparting to it a better flavour, as a strain of commercial importance for the whole Volga area, its blossoms were fertilized with pollen of Red Winter Calville.

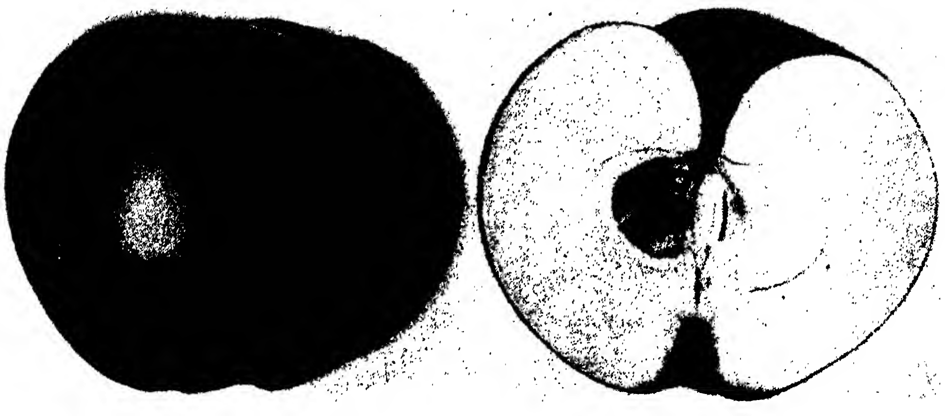


Fig. 78. Fruit of Calville Anisovy

The seed obtained from the cross sprouted in 1912. The seedling bore fruit for the first time in 1920, the ninth year of its life.

Shape of fruit: conical, Calville-like, markedly ribbed (see Fig. [78]).

Colouring: whitish-pink, with a glossy bright-scarlet side, with white tiny dots beneath the rind spread over the entire surface.

Size: length 68 mm., diameter 76 mm., weight 153 gr.

Stem: short, 10 millimeters in length, thin, sunk in a deep narrow cavity.

Calyx: closed, situated in a deep ribbed basin.

Core: broad, with closed carpels and a large axial cavity.

Seeds: fully developed, medium size, light brown.

Flesh: fairly juicy, solid, winy sour-sweet, with a strong pleasant fragrance.

Ripening time: becomes fit for use in November; attains full ripeness in December and keeps fresh in storage until March, without wrinkling, rotting, or losing any of its external and gustatory merits.

[1] "Pertsovka" is the property of the apple Anis to become pungently bitter in storage.

Fig. 79. Leaf of Calville Anisovy

Properties of tree: distinguished by complete hardiness; growth fairly good; branches resilient, enduring, hold fruit firmly in strong winds; not exacting as regards soil; fairly fertile.

A first-rate commercial variety for northern regions.

1929

KANDIL-KITAIKA

In order to produce for the population of the central belt of the U.S.S.R., with its severe climate—if not a perfect genuine variety of Crimean Kandil Sinap so far unsurpassed in the South for its graceful shape, and outstanding beauty and splendour of outward colouring—at least a strain very close to it as regards flavour and appearance, blossoms of the first flowering of a

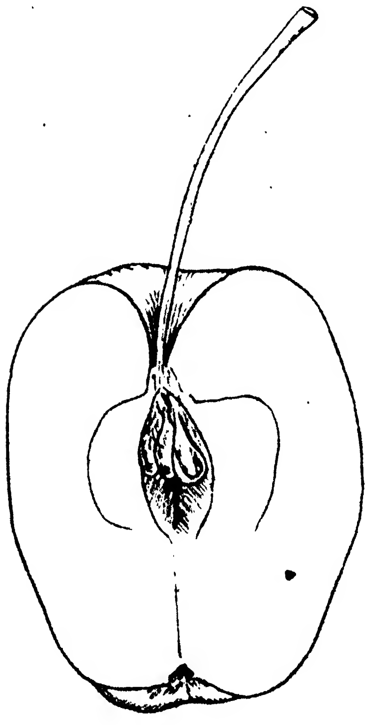


Fig. 80. Kandil-Kitaika, first bearing (drawing by I. V. Michurin)

Fig. 81. Leaf of Kandil-Kitaika, first bearing

fifteen-year-old Kitaika were fertilized with pollen of Kandil Sinap. This was done in 1892.

The fruits ripened quite well, and I noticed no deviation whatever in their shape on that occasion.

The seeds from the fruits thus obtained were planted in boxes the same winter and placed in the open. The seeds sprouted in the spring of 1893. In the first winter the seedlings did not in the least suffer from

the frost, but in the winters that followed this acquired hardiness began to disappear.

The seedlings began to deviate in external appearance towards the Kandil Sinap.

In 1898, in order to overcome the reviving influence of the Sinap, I worked the buds of one of the best hybrid seedlings on the crown of the maternal plant, a Kitaika, so as to reinforce in the hybrid seedling the mother's hardiness.

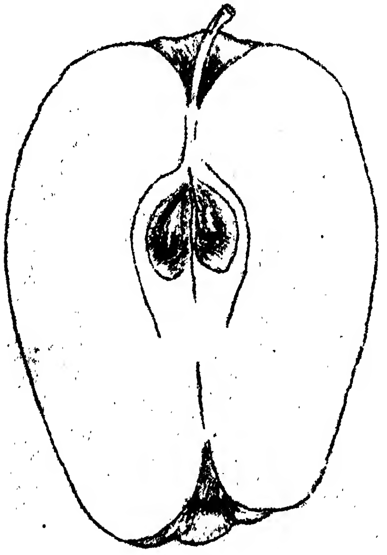


Fig. 82. Fruit of true Kandil Sinap (drawing by I. V. Michurin)

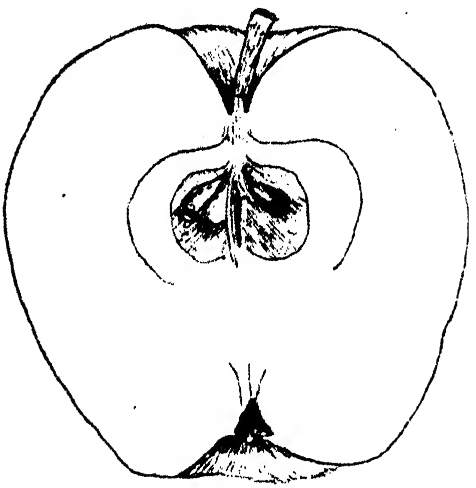


Fig. 83. Kandil-Kitaika, fourteenth bearing (drawing by I. V. Michurin)

Next year I left side by side with the shoots which had grown from the budded eyes a large part of the Kitaika branches, without pruning them—hoping, not without reason, that the previously observed influence of the Kitaika on the hybrid seedlings in respect to increasing their hardiness would be considerably enhanced by such grafting. I reasoned that the remaining part of the Kitaika crown with its foliage was bound in one way or another to exert a dominating influence on the form building of the still young grafted strain, which had not yet developed complete stability, particularly in view of the fact that its own foliage was very small. This was brilliantly borne out by the facts.

This time the influence of the mother, i.e., the Kitaika, on its own offspring was not slow in manifesting itself.

In the following years the grafts developed splendidly, showing no signs of being any the worse for the frosts.

I gradually removed the remaining part of the Kitaika branches and at last, in 1902, the sapling bore the first fruit. The fruits were small, tasteless

Fig. 84. Leaf of Kandil-Kitaika

and barely reached a weight of 38-40 gr. They were so small and unattractive that it positively seemed that the new strain was not worth bothering with. Only the shape and structure of the leaf blades resembled Kandil Sinap.

The fruits survived only until December, when they began to wrinkle and dry up. Their seeds gave no sprouts. In brief, anyone else in my place would have unhesitatingly destroyed the sapling as unfit. But, on the basis of my numerous experiments in breeding other varieties of fruit trees from seeds, I knew that the qualities of a new strain cannot be judged by the fruits of the first crop, and that most new varieties, even if not all without exception,

required several years to bring the formation of their fruits to perfection. I therefore kept the sapling, watched it carefully, observed the alterations in the fruits, took annual photos of cross sections of the fruits, and recorded all morphological and biological characteristics of the new strain.

In all the subsequent years, after the first fruiting, the fruits of the Kandil-Kitaika gradually improved in all respects, and in 1906 their weight reached 130 gr., whereas the fruits of the real Kandil Sinap weighed 128 gr.

As the weight of the fruits increased, their size, naturally, also increased, the flavour of the flesh quickly improved, the colouring changed and the period during which they could keep fresh in winter storage considerably lengthened. Already in 1905 they kept fresh until March. Beginning with the crop of 1904 the seeds of the fruits began to germinate excellently. Whereas in the first year of fruiting the hybrid's fruit weighed 38 gr., in the fourteenth year they weighed as much as 150 gr.

In the eighteenth year after the first fruiting, in 1920, when the summer was extremely dry, the fruits reached 210 gr. in weight, 79 mm. in length and 78 mm. in diameter.

In the twentieth year, 1922, the Kandil-Kitaika's fruits, owing to insufficient moisture, did not develop enough in diameter, but the length was normal; their shape therefore became more like that of the Crimean Kandil Sinap (see Fig. [82]), and their colouring was bright-yellow with a scarlet side. The storage quality underwent no change. In the spring of 1924, the twenty-second year of fruiting, the branches of the tree were pruned in order to induce a stronger growth of summer shoots, with a view to obtaining cuttings for budding. Owing to this, some fruits weighed only 158 gr.

The above is an account of but a small part of my observations of the life and development of the new hybrid variety Kandil-Kitaika. I now pass on to a pomological description of the strain.

Shape of fruit: medium size, oval-conical; some are of a very beautiful oval-cylindrical shape.

Colouring: when just picked, the fruit is greenish with a diffused carmine-pinkish tint on the sunny side; in storage the colouring, by February, changes into yellow with a deep bright carmine-pink diffused tint on the sunny side of the fruit, sharply interrupted in spots shaded by leaves or where it touches neighbouring fruits.

The rind is glossy, very compact, little susceptible to attacks of fungous parasites, covered with slightly protuberant whitish spots under the skin.

Size: length 78 mm., diameter 64 mm., weight 165 gr.

Stem: thin, long; sunk in a deep and narrow cavity.

Calyx: half-open, with large green sepals; situated in a sloping funnel-like basin.

Core: above average size, somewhat closer to the stem.

Seeds: full, medium size, pointed, light chestnut in colour.

Flesh: white, solid, winy-sweet, with the excellent characteristic flavour of the Crimean Kandil Sinap, but juicier. In the opinion of many, the Kandil-Kitaika's flavour excels that of the Kandil Sinap.

Ripening time: fruits picked in the first half of October complete ripening and acquire their good gustatory qualities in storage only by February.

Ripeness for consumption begins already towards the end of December. Under normal storage conditions the fruits can easily keep fresh until April, and they possess the remarkable ability of not rotting or losing any of their excellent flavour qualities while in storage.

Properties of tree: growth of medium strength, the crown narrowed, paniculate, with flexible and fairly long shoots of a dark-brown colouring and with a slight down on their ends.

The leaves are oblong in shape, curled like a trough and distinctly corrugated along the edges.

Their serrature is not deep; it is slanting and pointed.

The upper side of the leaf blade is smooth, the underside is downy. The petiole is long, thin, thickening considerably at the point of connection with the shoot; it is of a lilac colouring.

The fruit buds are placed on the ends of one-year-old shoots and also on two-year-old side shoots.

The yield is generous. The tree is distinguished by complete hardiness in the central belt of the R.S.F.S.R.

Beyond this radius it becomes quite sensitive and susceptible to frostbite.

The seedlings of this Kandil-Kitaika hybrid in the second generation were all, without exception, hardy and with characteristic features of the Sinap.

This gives grounds for hoping to obtain in the future several hardy kinds of Sinap and grow these valuable varieties in more northern sections of the R.S.F.S.R.

For its flavour and appearance, and also for its ability to keep fresh until the spring, the Kandil-Kitaika may be regarded as a first-rate strain without rival among all the apples of the central belt of the U.S.S.R.

1929

KITAIKA ANISOVAYA

In 1909, with the aim of imparting to Anis Barkhatny greater hardiness so as to make it suitable for the more northern sections of the U.S.S.R., I used pollen of this strain to fertilize a Kitaika. The seed obtained from the cross sprouted in 1910. The seedling first bore fruit in 1915, the sixth year of its growth.

Shape of fruit: round, the largest diameter below the middle of the fruit: it is sometimes ribbed, but in general this is hardly noticeable.

Size: length 39 mm., diameter 45 mm., weight 50 gr.

Colouring: light, greenish-yellow, with a delicate diffused reddish-pink tint on the sunny side; the contrast of hues is well expressed and makes the fruits very beautiful. The surface of the fruit is covered with a whitish bloom.

Stem: 17 mm. long, of medium thickness, woody, of a green colouring almost entirely hidden beneath a brownish-carmine tint. The cavity of the

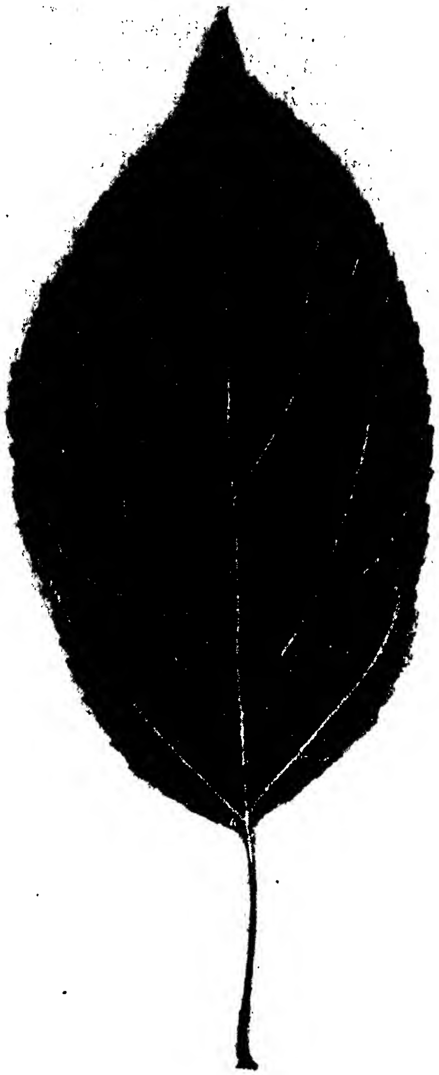


Fig. 85. Leaf of Kitaika Anisovaya

stem is small, sloping cone-like, covered with a yellow-brown rust, sometimes dirtyish.

Calyx: large, closed, with protruding sepals, irregular in shape, mostly narrowed on the sides by little knobs; situated in a shallow basin of an irregular angular-rounded shape.

Core: large, of broad onion-like shape, with closed carpels, the partitions between the latter smooth, often with a few cracks.

Seeds: very small, well developed, rounded-oval, of a light yellow-brown colouring, in most cases one in a carpel.

Flesh: white, with a green shade, loose, juicy, of an excellent sour-sweet delicate flavour.

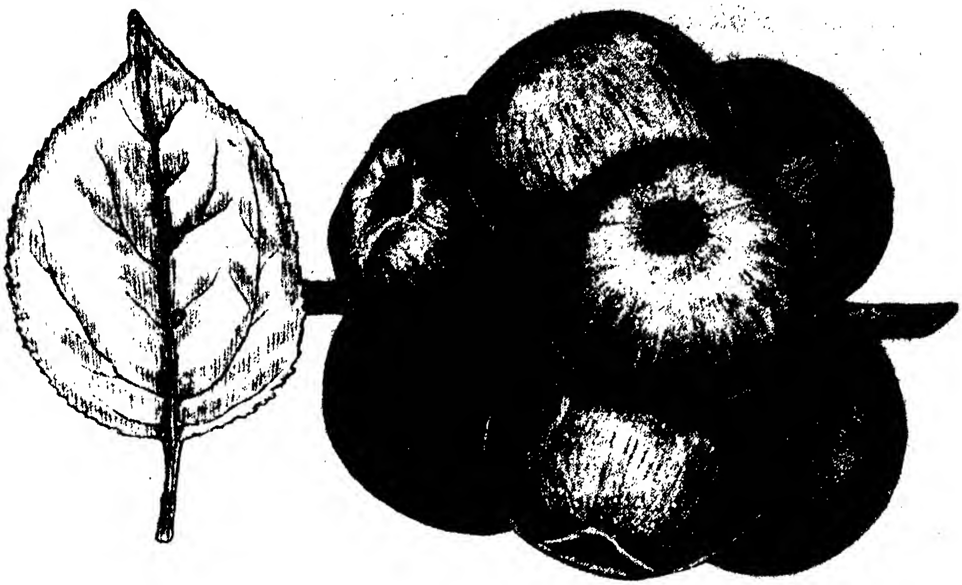


Fig. 86. Fruit of Kitaika Anisovaya (drawing by I. V. Michurin)

Ripening time: the fruits become edible long before the complete ripening, which is in itself quite early—late in July or in the very beginning of August.

Properties of tree: distinguished by complete hardiness; small in height, the fruits situated (see Fig. [86]) on the branches in clusters of seven. The wood is strong and therefore the branches never break when the crop is big or in strong winds. The Kitaika-Anisovaya is the earliest-maturing summer variety and is distinguished by unusual fertility.

One of the defects of this strain is that the specific strong fragrance, characteristic of its fruits only, attracts various insects. Bees, wasps, flies, butterflies and even mosquitoes whir in swarms over the ripening fruits.

On account of its outstanding frost-hardiness, fertility and the particularly early maturation of its fruits, it may be regarded as a good variety for the more northern sections of the U.S.S.R.

1929

KITAIKA ZOLOTAYA RANNAYA

Fruit varieties whose fruits ripen particularly early are very valuable for the reason that they can be sent early for consumption to the industrial regions. Such strains are particularly valuable in colder sections of the country with a short vegetation period, where the fruits of winter varieties usually fail to ripen, whereas the wood of the trees of early strains grows more compact than in winter varieties, and the former are therefore more frost-hardy than those with late fruit ripening.

All these considerations induced me, in breeding apple varieties for cultivation farther north, to take as parents for crosses: on the one hand, the Kitaika, as the most frost-hardy in our regions, and, on the other hand, the long-known strain Bely Naliv, whose fruits ripen very early and which is distinguished, besides, by great frost-hardiness. In 1894 I fertilized a Bely Naliv with the pollen of a Kitaika. The seed sprouted in the spring of 1895. The sapling first bore fruit in 1907, the twelfth year of its life.

The hybrid obtained from this cross, which I named Kitaika Zolotaya Rannaya, turned out to be an earlier strain than any in our parts.

The fruits of this hybrid, weighing thirty grams each, mature in the middle of July. This strain will be very valuable for growing in cold regions with a relatively short vegetation period, and this will make it possible to extend the boundary of apple distribution considerably to the north.

1932

KOMSOMOLETS

In order to obtain cultivated apple strains with the flesh of the fruit a beautiful red, I used pollen of the red-fruited hybrid Rubinovoye to pollinate the blossoms of a Bellefleur-Kitaika. The fertilization took place in 1916. The hybrid bore fruit for the first time in 1926. Most of the fruits are of an oblong, truncated-conical shape, somewhat resembling the Kandil Sinap (see Fig. [87]). The surface of the fruit is uneven, with deep depressions and protuberances. This is a characteristic feature of the strain. The basin and cavity in which the calyx and the stem are placed are deep, uneven, with large bulges. The fruit weighs eighty grams. Its colouring is deep rose diffused over the entire surface, brighter on the sunny side than on the shaded side. The entire surface is sprinkled with small greyish specks. The flesh is firm, juicy, sweet with a pleasant acidity; the colouring of the flesh is pink, turning deeper near the core and closer to the surface. The seeds are light red. The fruits can keep fresh in winter storage until February-March. The tree is quite hardy to our severe frosts.

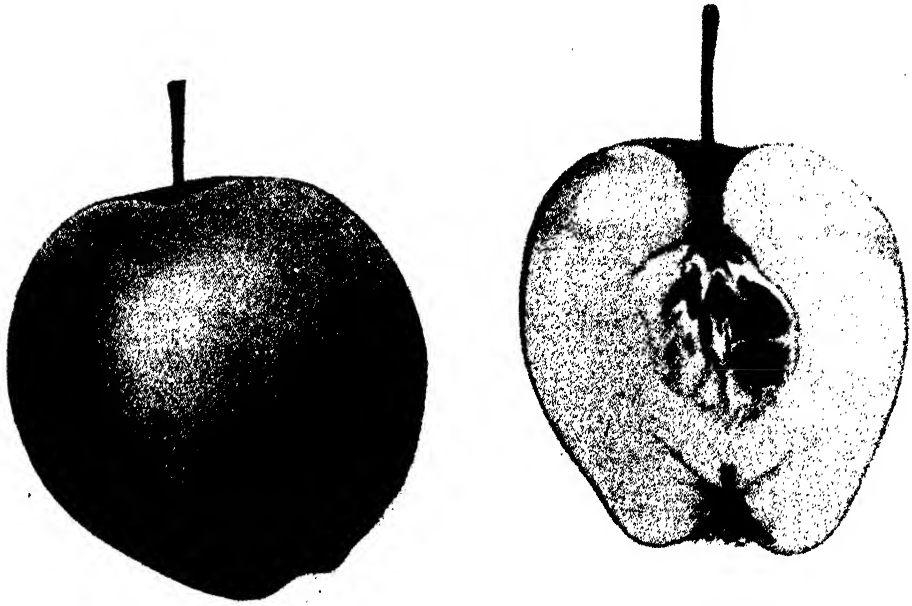


Fig. 87. Fruit of Komsomolets apple tree

For the exceptionally beautiful external colouring of the fruits and also of the flesh, I have named this strain Komsomolets.

It is a first-rate strain, suitable for growing in kolkhozes and sovkhozes.

1932

KRASNY SHTANDART

This strain I have bred with the same aim as the Komsomolets, i.e., with the aim of obtaining a new kind of apple with a beautifully coloured flesh. The Krasny Shtandart originated from a cross between Pippin Shafranny and Rubinovoye made in 1915. The sapling first bore fruit in 1922. The fruit is oblate in shape, of a brownish-red colouring diffused over the entire surface, with a deeper hue on the sunny side. There are also rather large spots of a greyish-brown colour with brown dots in the middle. The stem is sunk in a deep narrow cavity, and the calyx is situated in a wide, distinctly ribbed basin. The fruit weighs seventy-five grams.

The flesh is juicy, of a sour-sweet flavour, and with a pretty deep rose colouring. The tree is quite frost-hardy in severe winters.

In our parts this strain may be reckoned as third-rate, but, in the Volga area, according to reports, it ranks among the first-rate strains.

1932

COULON-KITAIKA

For the purpose of introducing into the central zone of the U.S.S.R. a good autumn variety of apples possessing the qualities of southern varieties as regards flavour and appearance, I fertilized in 1906 a Kitaika apple tree with the pollen of a Coulon-Reinette. The result, unfortunately, was not entirely successful.

The seed obtained from the crossing germinated in the spring of 1907.

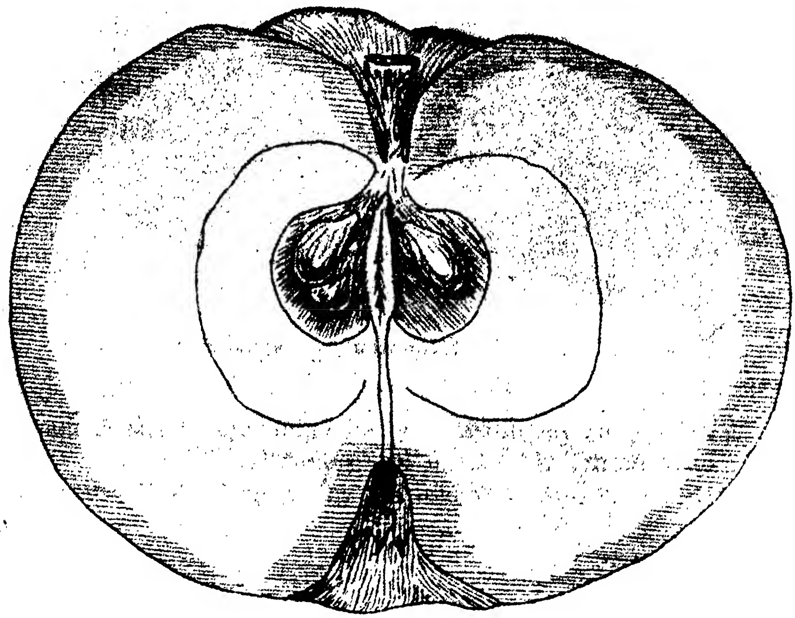


Fig. 88. Fruit of Coulon-Kitaika (drawing by I. V. Michurin)

The seedling bore fruit for the first time in 1918, its twelfth year of growth.

Shape of fruit: turnip-shaped, similar to the Calville, ribbed (see Fig. [88]).

Colouring: light green with sharply conspicuous grey spots scattered over the entire surface of the fruit.

Size: length 70 mm., diameter 92 mm., weight 220 gr.

Stem: very short, 8 mm. long; exceptionally thick, up to 5 mm.; emerges from a deep, rather ribbed cavity.

Calyx: open, very wide; the basin has sloping sides and is deep and ribbed.

Core: relatively small with closed carpels.

Seeds: large, full, of dark-red colour.

Flesh: friable, Calville-shaped, juicy, sweet with a trace of sour.

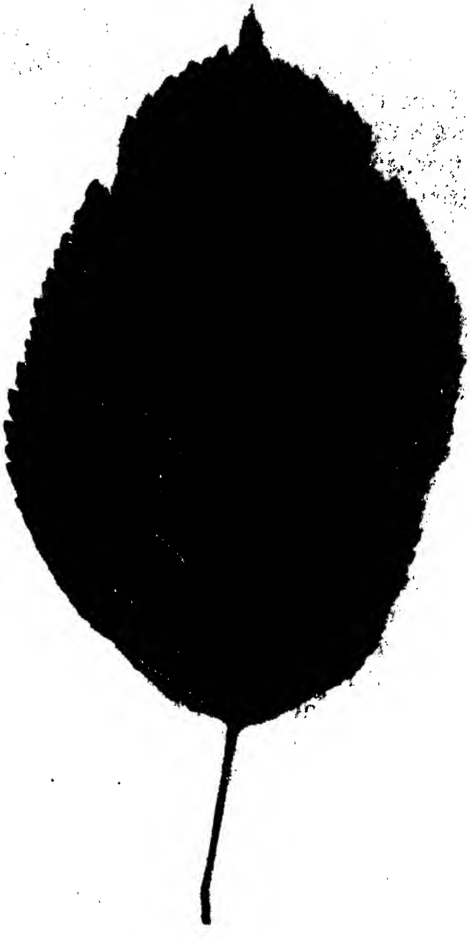


Fig. 89. Leaf of Coulon-Kitaika

Ripening time: December-January.

Properties of tree: the tree is short, the wood firm; two of the fruits of the first bearing adhered to the branches quite loosely, ripened early and began to spoil as early as the middle of November. At the second bearing, however, in 1920, the tree's yield was considerable, and, despite an unusually dry summer, the fruits adhered to the branches remarkably well, and, besides, the capacity to keep fresh in winter increased greatly. Thus, from an autumn variety the new fruit became a winter one. The tree's yield is a rather good one, and the tree is quite hardy. Although as regards shape and size this variety's fruits are similar to the Coulon-Reinette, the variety has to be classified as second-grade because of its inferior taste.

1929

MICHURIN PARADISE

There are no hardy stocks for dwarf apple-tree cultivation in the central and northern zones of the R.S.F.S.R. The southern varieties of dwarf stocks of the Paradise, Doucin and others are not hardy enough for these localities and in severe winters, when the ground freezes to a depth of more than a metre, these stocks often are completely killed by the frost. The propaganda that the Siberian crab (*Malus baccata B.*) makes a good dwarf stock for apple trees will bring nothing but harm.

The Siberian crab has a large number of natural varieties, and tests have proved all of them to be quite unsuitable for stocks. Far from all varieties take well, or grow well, when grafted on to them; the vegetative periods of the stocks and scions do not coincide properly; the fruits of cultivated varieties that are grafted on to the Siberian crab deteriorate rather than improve; they do not begin to bear fruit any earlier than when grafted on to other stocks. In dry summers the trees suffer from lack of moisture, inasmuch as the Siberian crab's roots spread close to the surface and do not penetrate deep into the soil.

With the object of breeding a cold-resistant dwarf stock for apple trees I crossed, in 1901, *P. prunifolia W.* with a *Pyrus Malus paradisiaca L.* The seeds germinated in the spring of 1902.

The seedling bore its first fruit in 1928, its twenty-seventh year. The tree has a compact, narrow pyramidal crown, and is but one to two metres in height. The fruits are oblong-oval in shape, 30 mm. long and 22 mm. in diameter; of light-straw colour, and the flavour good. They ripen in storage as early as December. The tree has a rich minutely ramified root system that penetrates deeply into the ground.

It fully withstands our severe winter frosts, never having been damaged by frost for thirty years now. Even the winters of 1927 to 1929, when the temperature dropped to $-38°$ C., left no trace of damage, not only on the branches, but also on the fruit buds. The fruit yield, after these severe winters, was a full one.

The tree does not develop root shoots, but the sprouts on the lower part of the stem above the surface of the soil readily take root when planted as cuttings in beds out of doors.

1932

PARADOX

This is a seedling of a hybrid from a Slavyanka fertilized by pollen from an Oleg. The process of rearing this variety included a test study, continued over a period of nine years, of the influence exerted on it by the dry air of a heated living room with the double window frames left in during the summer. With this in view, the seed obtained after the crossing was planted in a pot where it germinated in 1902, and the seedling grew for nine

years without being transplanted and without any sprinkling with liquid fertilizer.

Not once during the entire nine years was the pot with the seedling taken out of the room into the open air, and the plant was never exposed to a temperature lower than +12.5°C.

Reared under such conditions for nine years commencing with the earliest stage of the seedling's development, considerable changes in the properties

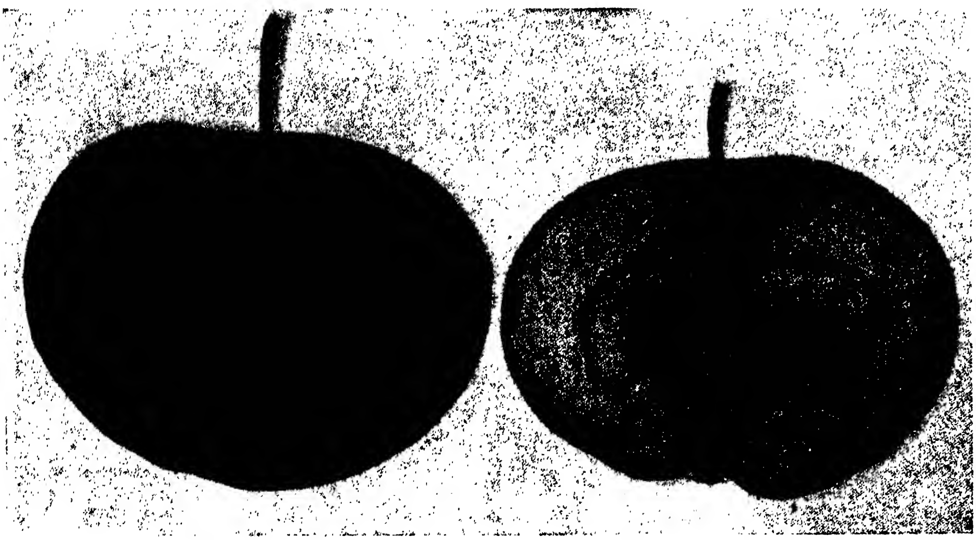


Fig. 90. Fruit of Paradox

of the variety might have been expected, such as frailty, reduction of its vegetative parts, longer vegetation, particularly small-sized fruits and, in general, an inclination toward wild growth in consequence of the lack of many of the usual conditions necessary for the development of a plant. As a matter of fact, however, when a cutting taken from this seedling was whip-grafted in 1911 on to the crown of an adult tree in the open air, the expected sharp changes did not occur.

This new variety, Paradox, has turned out to be quite hardy, and from its first bearing, in 1922, has yielded large fruits possessing good winter storage qualities.

Hence, the rearing of hybrids in warm temperatures, provided the air is kept extremely dry, does not, in certain cases, prevent them from developing the property of frost resistance. This is evident also from the way new varieties of Mongol apricots have originated.

Consequently we may hope to obtain varieties hardy to our climate from plants found in dry and mountainous places, even though the climate there is warmer than ours.

Shape of fruit: oval-conic (see Fig. [90]).

Colouring: greenish with bright scarlet and deep-red tint; on the fruit's surface can be seen sparse whitish subcutaneous spots.

Size: length 85 mm., diameter 87 mm., weight 223 gr.

Stem: 22 mm. long, medium thickness, emerges from a deep cavity.

Fig. 91. Leaf of Paradox

Calyx: closed, with green sepals; lies in a very deep, narrow basin.

Core: in the larger fruits has semideveloped open carpels of wide shape.

Seeds: mostly only in a rudimentary state; developed seeds are found more often in small-sized fruits; they are short and full.

Flesh: juicy, small-grained composition, has an insipid sweet taste.

Ripening time: ripe for consumption in November; the fruits keep in winter storage until the end of April.

Properties of tree: distinguished for thorough hardiness, the yield is rather good; is not exacting as to soil. The variety is not self-pollinating (self-sterile). In view of the complete absence of acidity from the fruits the variety may be classified as third-rate.

1929

PIPPIN-KITAIKA

This is a hybrid obtained from the Glogerovka fertilized in 1907 with the pollen from a Kitaika. Germination of the seed obtained from the crossing took place in the spring of 1908.

The seedling bore its first fruit in 1917, when in its tenth year. The fruits of the third harvest exceeded the Glogerovka in size and weight.

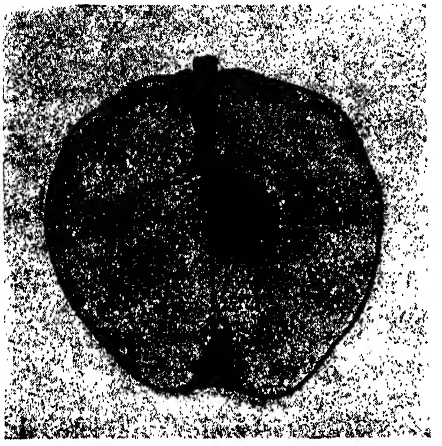


Fig. 92. Fruit of Glogerovka

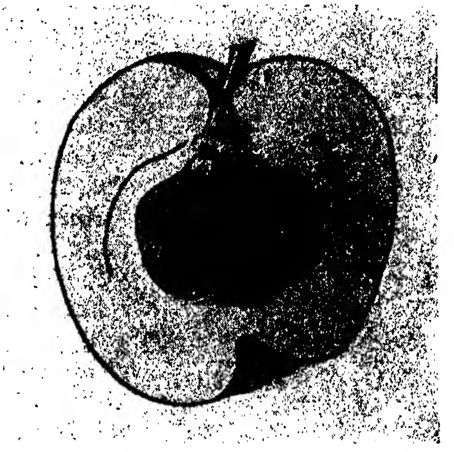


Fig. 93. Pippin-Kitaika, first bearing (drawing by I. V. Michurin)

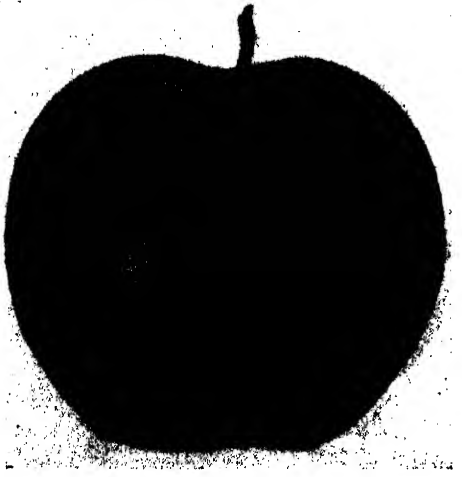


Fig. 94. Fruit of Pippin-Kitaika

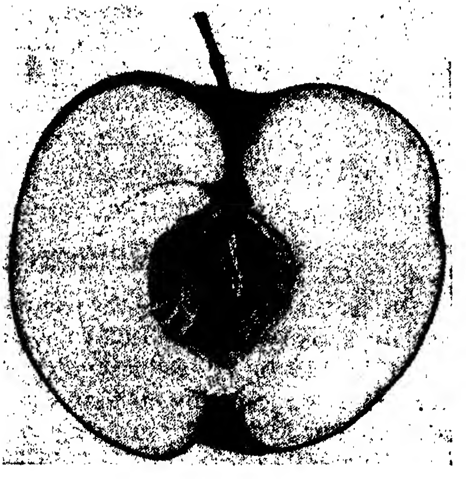


Fig. 95. Cross section of fruit of Pippin-Kitaika

Shape of fruit: quite changeable, but typical fruits in most cases have a round shape, somewhat narrowed toward the calyx, with the largest diameter in the middle. For the most part the fruits are regular, without ribs or with barely noticeable signs of them in the upper part of the fruit (see Figs. [94 and 95]).

Fig. 96. Leaf of Pippin-Kitaika

Colouring: whitish yellow, occasionally with a very light rose tint on the sunny side. There is a rather large quantity of translucent spots under the skin but they are barely perceptible.

Size: length 68 mm., diameter 73 mm., weight 132 gr.

Stem: 20 mm. long, of medium thickness; the cavity is rather wide, deep and only slightly ribbed.

Calyx: closed, with green sepals, is situated in a shallow, small, slightly ribbed basin.

Core: wide, with closed carpels of faintly marked contour.

Seeds: medium size, full, of light-brown colour.

Flesh: white, juicy, friable, of excellent taste.

Ripening time: suitable for consumption at the end of November or early December; the fruits keep fresh until March.

Properties of tree: distinguished for complete hardiness and good yield; the branches are arranged in a horizontal position in the crown, and have firm, resilient wood; the windfall during the summer is very small.

In 1922 Pippin-Kitaika fruits reached a length of 70 mm., 80 mm. in diameter and a weight of 160 gr.

For its good yield, long winter keeping quality of the fruits and excellent flavour, this new variety, Pippin-Kitaika, may unhesitatingly be recommended as a first-rate variety for the more northerly localities of the central part of the U.S.S.R. and as a second-rate one for its more southerly districts.

1929

PIPPIN SHAFRANNY

In order to obtain in the central zone of the U.S.S.R. a superior prize variety apple with admirable flavour and capacity for long winter storage, I fertilized in 1907 a Reinette d'Orléans with the pollen of a hybrid seedling derived from crossing a Glogerovka with a Kitaika. Germination of the seed obtained from the crossing took place in the spring of 1908.

The seedling first bore fruit in 1915, when in its eighth year.

The tree has a wilted branchy crown of the same shape as the Glogerovka.

Table III. Pippin Shafranny

The branches have a propensity for growing downward. Blossoming takes place later than usual; in this way damage to the blossoms from spring morning frosts is avoided.

Shape of fruit: oval-conic, narrower toward the calyx than toward the stem. The fruit is of medium size.

Colouring: the fruits are splendidly embellished in scarlet over the handsome saffron-yellow main colour.

In general the fruits are incomparably brighter and more beautifully coloured than the Reinette d'Orléans.

Size: length of fruit of the first harvest was 60 mm., diameter 59 mm., and weight 90 gr.

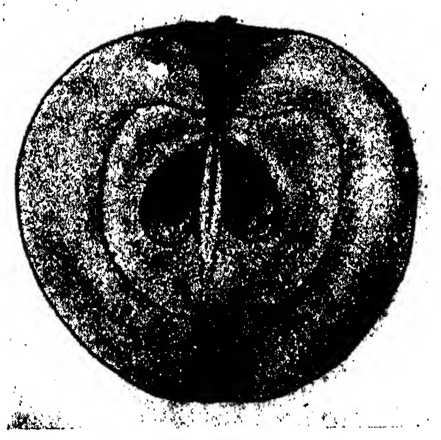


Fig. 97. Cross section of fruit of Pippin Shafranny

Fig. 98. Leaf of Pippin Shafranny

Stem: 24 mm. long, medium thickness, emerges from a slightly ribbed deep cavity.

Calyx: small, closed, situated in a rather deep ribbed basin.

Core: medium size, faintly outlined, the carpels are somewhat closed.

Seeds: medium size, full, pointed, of light-brown colour; produce seedlings mostly of the cultivated variety.

Flesh: compact, of yellowish colour, has a remarkably spicy, wine-sweet taste with a slight sour flavour, and a delicate fragrance.

Ripening time: begins to ripen for use at the end of November; the fruits can be kept until May without in the least losing their excellent flavour and external qualities.

Properties of tree: withstands the winter frosts of our parts. Observations in the spring of 1920 showed that as compared with our ordinary old varie-

ties, development of both the growth buds and the fruit buds commences from ten to twelve days later. That constitutes the great merit of this variety, since thanks to this feature the blossoms can escape damage from the spring morning frosts. Besides, a change in the entire habit is noted: from a horizontally drooping position the branches gradually grow more vertically, there are fewer bifurcate branches at the ends of the shoots, and the blossoms are arranged normally on the fruit spurs, and not on the young growth, as was the case during the first bearings of the mother tree.

In 1919 this variety became distinguished for its remarkable wind resistance: not a single fruit dropped from the branches of the tall tree. The fruits are arranged on the branches in clusters of three or four.

The leaves are of medium size, resembling in shape the Reinette d'Orléans leaf, which is medium oval, sharply pointed at the end, and somewhat widened at the stem.

The sprouts are rather thick, with the internodes of medium size; the wood is firm.

In the nursery's rather poor, loamy and sandy alluvial soil the mother tree produces an abundant harvest every year.

During the eighteen years I have observed this tree no damage of any kind has ever been noticed either from frost or sun scorch.

The tree and the fruits are little and seldom attacked by pests; this makes the variety highly valuable for large plantations.

The Pippin Shafranny is irreplaceable as a maternal parent for crossing with other varieties. In this respect only the Bellefleur-Kitaika, a variety newly bred by me, can compete with it. The Pippin Shafranny variety has proved hardy in Ivanovo Region at N. Dianov's place, situated at 58° N. Lat., some 500 km. north of Michurinsk.

Because of its especially beautiful exterior and its fine flavour I particularly recommend this variety as a first-rate one meriting the most extensive commercial cultivation in the central, northern and even southern zones of the U.S.S.R.

1929

REINETTE BERGAMOTTE

Many people are probably aware that almost all seedlings grown from the common Antonovka seeds incline towards the wild forebears, *Malus sylvestris Mill.* In contrast, the Antonovka-Kamenichka and the 600-gram Antonovka yield quite a considerable proportion of seedlings with pronounced typical signs of culture; this becomes apparent particularly when planting round seeds selected from fruits of these varieties.

Well, then, in my nursery, one of these almost completely round seeds of the 600-gram Antonovka produced the new variety being described, an excellent one as to the taste and appearance of its fruits.

The seed was planted in January 1893. The following summer, in 1894, a luxuriant, fine-looking seedling developed from the sprout; its leaves were round in shape and were very downy.

It should be mentioned that down is very rarely found on leaves in the first year of the seedling's growth. With the object of ascertaining the influence of the stock on a new variety that is joined with it at the earliest possible stage of the variety's development I grafted, that same summer, buds taken from a seedling onto the crown of a very vigorous wild three-year-old pear tree. The grafts took splendidly, and in the following two years, with the gradual removal of parts of the pear wilding's crown, the grafted variety of apple rapidly developed into a very beautiful little crown.

To my amazement, however, the remarkable down of the leaves and shoots thinned out greatly each year, and were it not for the fact that the long shoots continued to be of a considerable thickness, one might have suspected the degeneration of the new variety.

As it turned out later, however, this would have been a gross error, since the change did not indicate that the variety was running wild, manifesting atavism (a return to its forebears), but rather that it was due to the influence of the pear stock on the young scion of a variety which had not as yet succeeded in developing sufficient stability, and that this influence was expressed in the mixing up of the apple and pear characters.

Then, notwithstanding the vigorous and healthy development of the apple variety grafted onto the pear stock, the latter's stem became quite sickly in the spring of the second year after the grafting. Something in the nature of dry gangrene appeared on the stock, so that I had to do something to save the graft of the new variety from perishing.

Not wishing to subject the graft again to the influence of an apple stock and thus have it lose the changes acquired as a result of the influence of the pear stock, I thought it best to bend the pear's stem down to the ground and root the graft at the point of union with the pear tree, where, by the way, there was a large excrescence.

The layer, as I expected, took root splendidly and astonishingly fast.

By gradually pruning the unnecessary branches of the former crown I produced a stem easily and quickly.

In 1898 (the fifth year after germination) the young tree bore the first fruits. If we exclude the time the plant's development was delayed due to the grafting and subsequently the rooting, then the phenomenally early first fruit-

Thus, as early as the first bearing the shape of the leaf blades and their surface changed considerably from what was observed in the first period of growth on the pear wilding: the blade became larger, took the shape more usual for apple trees, but the leaf's contour altogether resembled that of a pear. The down on the underside became thicker, the shoots, too, became covered with pubescence and their round, smooth surface yielded place to a faceted one.

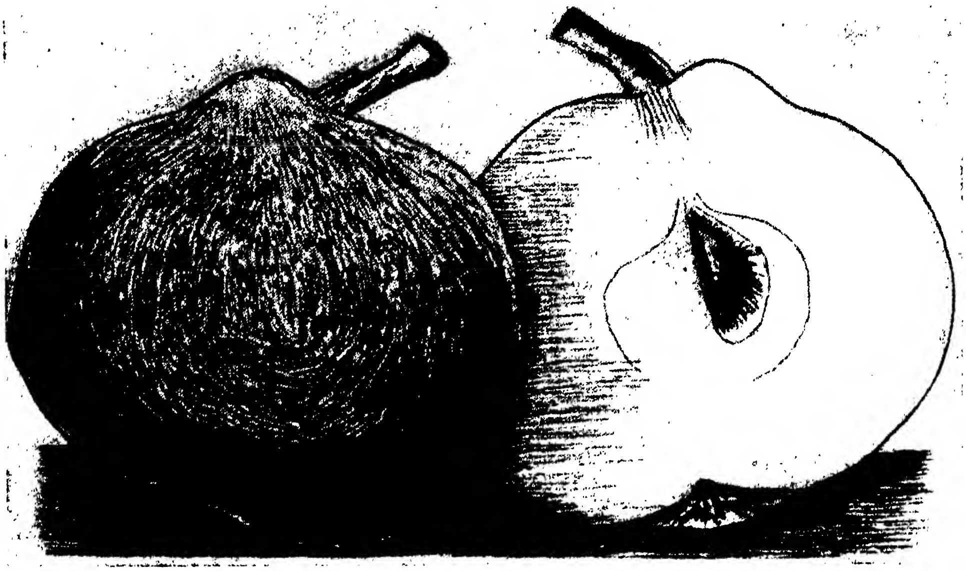


Fig. 99. Fruit of Reinette Bergamotte, first bearing (drawing by I. V. Michurin)

The change was reflected especially clearly in the fruits of the first yield in 1898, which had the appearance and shape of pears (see Fig. [99]). The stem of the fruits of the first crop was very thick, short, with a lateral accessory green protuberance; it was placed, strongly slanting, not in a shallow cavity, as is usual with the fruits of apple trees, but on a prominently projecting asymmetrical green protuberance, as is the case with the Bergamotte. That is why I named this variety Reinette Bergamotte.

I repeat, the fruit's general shape and the appearance of its colouring were more like a pear's than an apple's.

The colour was bright ochre-yellow with a scarlet glow on the side exposed to the sun. The protuberance and the adjacent portion of the fruit were a brilliant light green. The flesh was compact, prickly and had an excellent spicy-sweet taste with a slightly sour flavour. The fruits kept until April. The seeds of the first fruits were round and large but did not germinate. In the following years the fruits changed somewhat, approximating the usual shape of apples.

Shape of fruit: in the eighth year of the seedling's bearing—large, turnip-shaped (see Fig. [100]).

Colouring: the rind is brilliant, compact; the fruits picked green from the tree assume a bright-yellow colour with a scarlet glow on the side exposed to the light. Over the entire surface of the fruit whitish spots under the skin are perceptible.

Size: length 58 mm., diameter 77 mm., weight 171 gr.

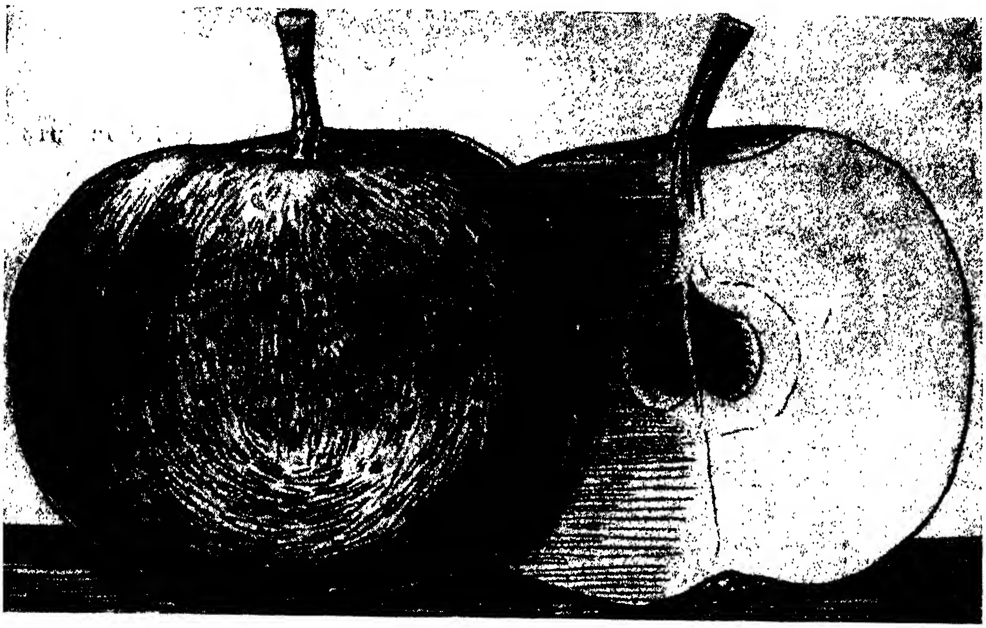


Fig. 100. Fruit of Reinette Bergamotte (drawing by I. V. Michurin)

Stem: thick, 20 mm. long, with a slight lateral protuberance on the lower part, is not placed in a cavity (there is no cavity), but on a completely filled, slightly protuberant area of green colour.

Calyx: open, in some fruits partly open, placed in a very small, sloping basin.

Core: highly bulbous in shape, with closed carpels.

Seeds: full, now no longer round but oblong, light-brown in colour.

Flesh: white, and only at the point where the pedicle is attached is it green; generally compact as is characteristic of the Reinettes, has a delicious spicy-sweet taste with moderate sourness and a slightly oily flavour.

Ripening time: this variety's fruits should be picked rather late, but earlier picking, say in the second half of August, will not hurt them. The fruits ripen in storage towards the end of December and easily keep in good condition until summer.

Properties of tree: vigorous growth, knots are rare; shoots are long and faceted toward the ends, downy, of medium thickness. The leaves have a

wide, roundish shape; the dentation is large and obtuse but not deep; they are of medium size. The flower buds are placed at the ends and over the entire length of the shoots; the yield is rather generous; the fruits hold firmly to the tree and very few drop to the ground.

Because of its absolutely perfect hardiness, long winter-keeping capacity and the good qualities of the fruits, this variety has a good future in our locality. It is first-grade.

1929

MICHURIN SINAP

This variety originated from a seed of a Kandil-Kitaika planted in 1913. Fruiting commenced in 1922.

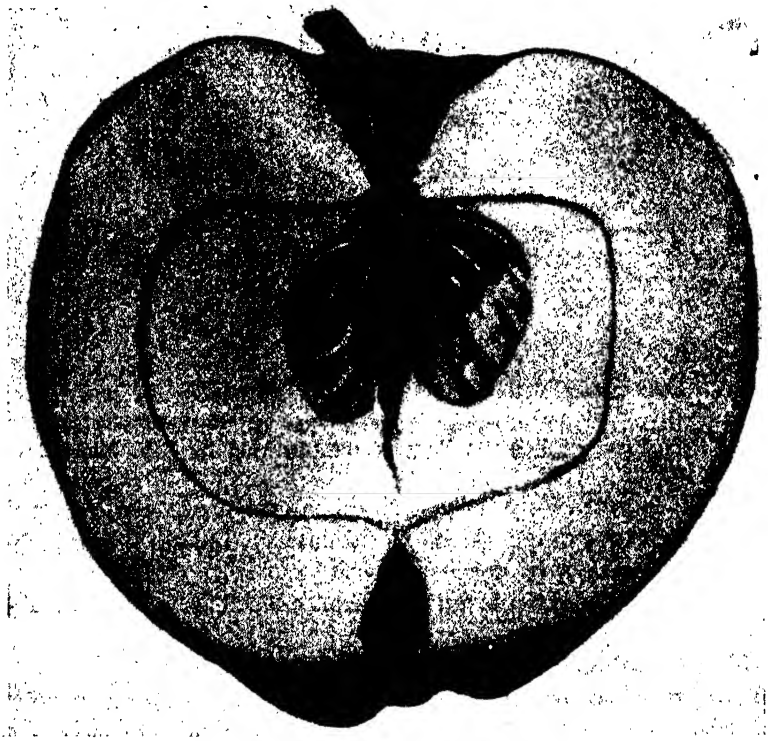


Fig. 101. Cross section of fruit of Michurin Sinap

The fruit has an oblate shape, with most fruits asymmetrical. The colouring is a pale-greenish yellow, the surface being dotted with whitish spots under the skin; there is a diffused red glow on the side exposed to the sun. In general, the fruit has a fine appearance. It weighs 70 grams; the stem is long and thin and is situated in a narrow, deep, regular cavity. The calyx

lies in a deep, wide and ribbed basin. The core is small, bulb-shaped, and the flesh is prickly and has a refreshing sour-sweet taste.

The tree well withstands our severe winters.

The fruits keep until December.

It is an excellent late-autumn variety. In view of the fact that some of its fruits are affected by spottiness while still on the tree, and some dropping to the ground has been observed, this variety should be classified as second-grade.

1932

SLAVYANKA

With a view to the possible elimination of the many defects of our Russian traditional Antonovka by hybridizing it with the best foreign variety, I fertilized, in 1889, the blossoms of a common Antonovka with the pollen of

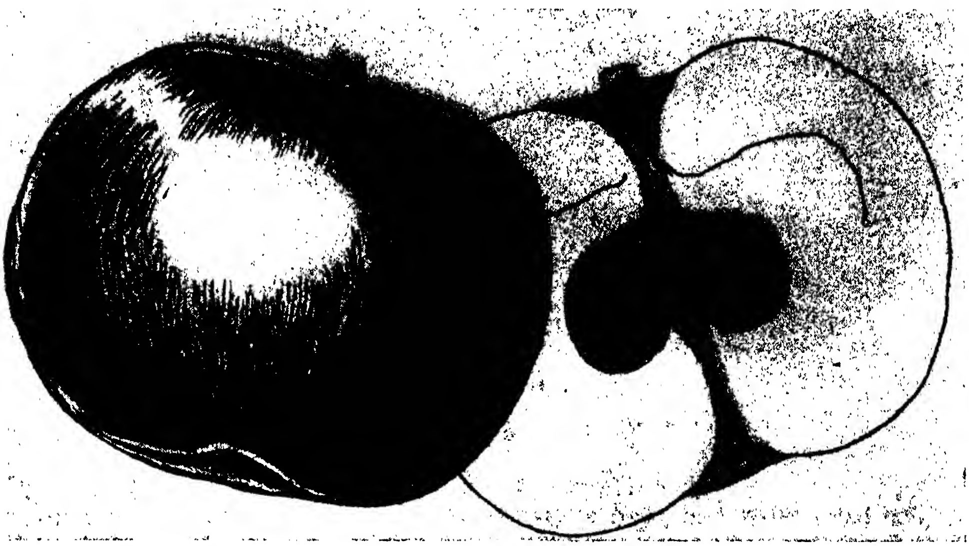


Fig. 102. Fruit of Slavyanka, first bearing (drawing by I. V. Michurin)

an Ananas-Reinette. The seed obtained from the cross germinated in the spring of 1890.

The new variety, which I named Slavyanka, bore its first fruit in 1896, i.e., in the seventh year after germination. From the very first year of fruit bearing, fruit buds appeared not only on the two-year-old branches but also on the one-year-old shoots of the previous year's growth. As is known, this occurs rather rarely in the case of apple trees and always is a sure sign of a variety's particularly generous yield.

In subsequent observation of Slavyanka trees over a period of thirty years I found that as compared with other varieties of cultivated apples the blos-

soms of this one possess a marked resistance to spring morning frosts and set in years when the blossoms of practically all other varieties are found to be killed by frost, as was the case in 1913, for example.

After an unusually early spring that year, came severe frost with the temperature dropping to −5°C. on May 1. The frost caught all the apple-tree varieties in bloom. Notwithstanding this, fruit set from the flowers on the Slavyanka trees and yielded a goodly number of fruits, whereas on a large number of trees of other varieties they did not set at all, or if apples did result there were no more than three to five per adult tree.

The Slavyanka's yield is generally very large and constant.

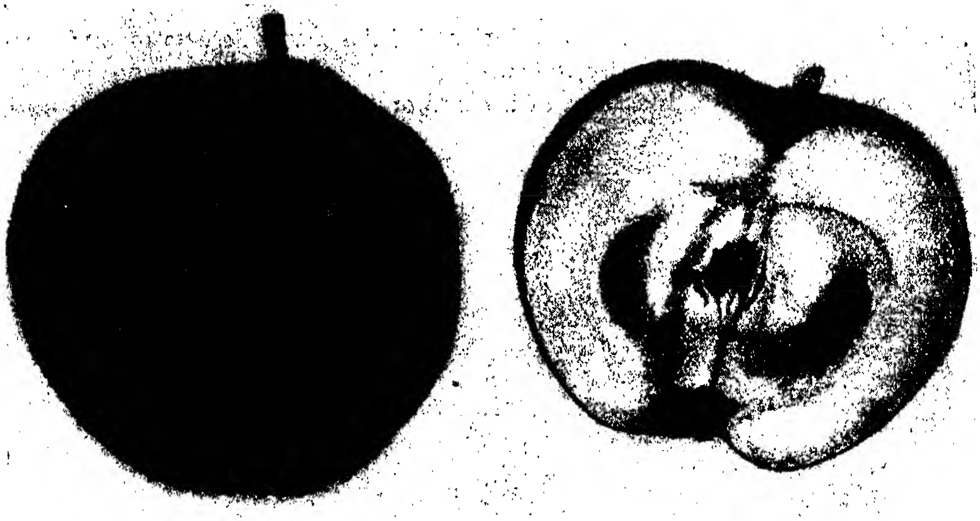


Fig. 103. Fruit of Slavyanka (reduced)

The trees grow and yield abundant crops in almost the same way under the most varied conditions in our localities, whether the soil is dry and sandy or black and humid; the only difference, an insignificant one, is that in dry places the fruits of the Slavyanka are somewhat smaller and are yellower in colour, while on black soil and in humid places they are larger and greener. Neither is the yield affected by apple trees of different varieties growing next to the Slavyanka trees.

It bears fruit well even when planted in isolation, since it is easily selfed.

Shape of fruit: turnip-round, sometimes superficial longitudinal depressions are observed, such as are found on the Babushkino variety (see Fig. [103]).

Rind and its colouring: smooth, rather compact, and less than other varieties affected by parasitic fungi or insects. When picked from the tree the fruits are yellowish green in colour, and on ripening in storage they acquire a light pale-yellow colour, sometimes with a light-scarlet glow on the side considerably exposed to the sun; over the entire surface of the fruit,

through the lustrous rind may be seen whitish spots sometimes with greyish centres.

Size: length 60 mm., diameter 70 mm., weight 107 gr.

Stem: thick, 10 mm. long, situated at the bottom of a shallow, sloping cavity, and only in rare cases does it reach its edges; the upper end is thick-

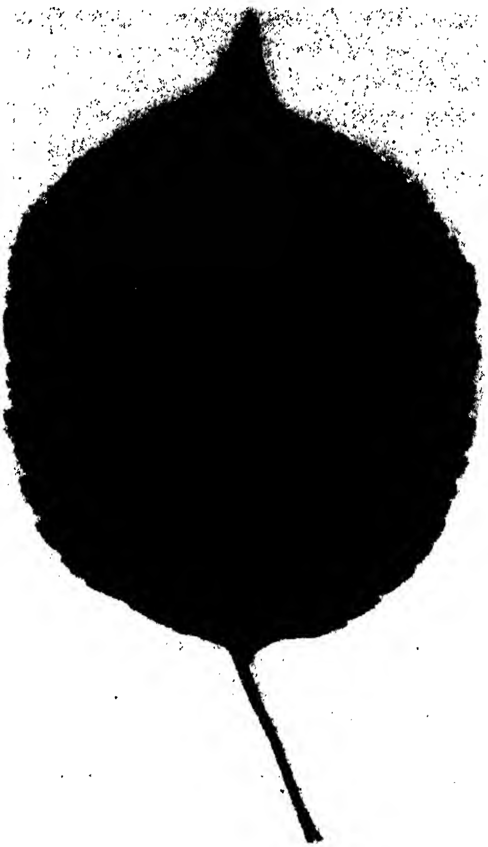


Fig. 104. Leaf of Slavyanka

ened greatly by a green-coloured lateral excrescence. This is an almost constant characteristic of all Antonovka hybrids.

Calyx: large, rather wide with five short and wide sepals inclining inward; situated in a ribbed basin of medium depth.

Core: small, narrow, with tightly closed carpels, completely separated from the tube under the calyx by a wide layer of solid flesh; this is rarely found in other varieties of apples.

Seeds: each of the five carpels contains two full seeds of medium size, light brown in colour.

Flesh: white, delicate and juicy; when fully ripe rather friable, and only when the fruits are considerably overripe (in April) do they become mealy. It has a pleasant taste, sweet and slightly sour; the fruits may be used fresh, or for soaking, pickling or for making paste.

Ripening time: the fruits should be picked at the beginning of September, but they ordinarily begin to ripen in January; they do not spoil in storage before the middle of spring.

Properties of tree: completely resistant to winter frosts in localities in the central and northern zones of the R.S.F.S.R. Observations over a period of thirty years have never shown a single case of Slavyanka trees being damaged by frost. The same may be said as to the immunity of the bark of the stem to scorchings. It has been unaffected regardless of the sharp changes in temperature in spring and winter.

The Slavyanka tree grows to medium size. The crown naturally grows to a regular, broad, paniculate shape with rare, relatively upright branches. The yield is extraordinarily large, with fruit buds even appearing over the entire length of one-year-old shoots. Both fruits and leaves are quite resistant to fungi parasites, and the blossoms are noteworthy for particular resistance to spring morning frosts.

In employing different varieties of stocks it has been found that when a Slavyanka was grafted on to seedlings of cultivated apple trees there was a tremendous difference: the trees developed more luxuriantly, the yield was greater and the fruits were better in quality. The results are somewhat poorer when it is grafted on to a wilding or Kitaika; when the *Malus baccata Borkh.* is used as stock the Slavyanka's good qualities are lowered.

Because of the short stem the fruits are pressed close to the branches; they withstand remarkably well the strongest gusts of wind and the percentage of windfall is very inconsiderable. This gives ground for recommending trees of this variety for planting in orchards in open places that are poorly protected from the winds.

For its great hardiness and yield this variety may be considered as first-class for planting in northern localities of the R.S.F.S.R.

1929

TAYOZHNOYE

When considering the development of fruit growing in the northern districts of our Union, particularly in the Urals and Siberia, we should bear in mind the rather severe climate of those localities and the extreme paucity of fruit-plant varieties there that are suitable for commercial cultivation. Hence, the prime and urgent need is to improve the assortment in those territories and supplement it with varieties of greater productivity.

On the basis of my sixty years of labour, I may state most emphatically that it is possible to develop fruit growing there notwithstanding the relatively rigorous climatic conditions of these northern areas.

With this in view I fertilized, in 1906, the blossoms of a Kandil-Kitaika with the pollen of *Malus baccata Borkh.* Germination took place in 1907, and the first bearing was in 1911, in the seedling's fifth year. The fruits very much resembled the ordinary Kitaika, but in many of them the calyx fell off, as is the case with the true Siberian crab.

This hybrid, in addition, manifested particularly vigorous and early bearing. Even one-year-old grafts on the wilding of the ordinary *Malus sylvestris Mill.* yielded fruits, something that does not occur with the grafts of

Fig. 105. Rooting of branches of Tayozhnoye apple tree

any variety whether cultivated or wild. This variety appears capable of being cultivated in cold areas where no other apple tree will grow and bear fruit; for in such places one- and two-year-olds may easily be covered with snow, and the snow-covered branches are sure to bear fruit.

Because of its exceptional frost resistance, which enables it to grow at the farthest limits of distribution of apple I named this variety Tayozhnoye. This variety, besides, may successfully be substituted for the Paradise as a stock for dwarf-trained apple-tree cultures, the more so since the Tayozhnoye branches readily take root by layerage (see Fig. [105]).

This variety, moreover, may render an important service in the role of intermediate grafts, i.e., the so-called mentors, for increasing and accelerating the fruiting of new varieties.

The fruit weighs 11 grams. The flesh is compact, semi-transparent and prickly, and has a good flavour; it will keep in winter storage until January.

This new variety is of great importance in the northernmost areas of apple cultivation not only for large-scale planting, but also for using as a component in hybridization; also it may be used for seed planting, to produce new local varieties under the rigorous climatic conditions of those parts by selecting specimens that manifest the greatest hardiness and yield.

In this way, by means of such labour the cultivation of apple trees may be pushed several hundred kilometres farther north.

1932

TRUVOR

As early as 1889, among a number of other experiments, I pollinated the blossoms of a Skrizhapel with the pollen of a Blenheim Reinette.

Fruits set and ripened well; they did not in any way differ in shape or colouring from the ordinary Skrizhapel fruits.

At the end of March 1890 the seeds were planted in a box which was placed outdoors. Later in the spring the shoots were pricked out in the usual way.

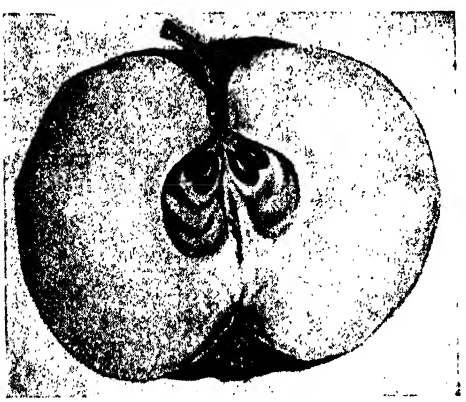


Fig. 106. Cross section of fruit of Truvor, first bearing (drawing by I. V. Michurin)

The first bearing of one of the selected seedlings took place in 1898, its ninth year of growth. The fruits of the first harvest were 50 mm. long, 65 mm. in diameter and weighed 110 gr. In 1899 when the nursery was moved to another section I also had to transplant the mother tree of this variety when it was already ten years old. The new soil was of silt and sand, and quite by chance the transplanted tree was placed in the vicinity of some adult Skrizhapel trees. And so, due to the influence of the pollen from the neighbouring Skrizhapel trees that fertilized the blossoms of the seedling—an organism still too young to have developed sufficient resistance to change resulting from repeated influence—the fruits of the transplanted tree changed considerably in the direction of the maternal parent, i.e., the Skrizhapel. But this change was confined only to the shape; as regards taste, the change in quality—if there was any at all as compared with the first fruit borne—was insignificant.

If in the given case we were to explain the phenomenon only by the change of soil, even then, on comparing so sharp a change in a new ten-

year-old variety with the barely noticeable deviations, that take place in old varieties under similar circumstances, we shall obviously have to recognize the fact that new varieties acquire full maturity and stability slowly. Although in the case described the variety gained in flavour, it lost much in appearance and beauty of the fruits.

Consequently this is yet another confirmation of the fact that the best qualities of hybrid seedlings, external as well as internal, depend on the rational rearing of the plants, i. e., on the wise and expedient care, and to a considerable degree on the quality of the soil, good nutriment, etc.

The difference in climatic conditions, however, does not constitute an essentially important handicap, if for no other reason than that, firstly, even abroad where the climate is comparatively better, fruit-tree seedlings, if reared simply as wildings, bear fruits that are sourish, small and unprepossessing just as in our country; secondly, every originator of new varieties is in a position to remove or prevent various undesirable characters by selection, or, to put it better, by selecting only such individuals as will prove good even in the rigorous climate of his locality.

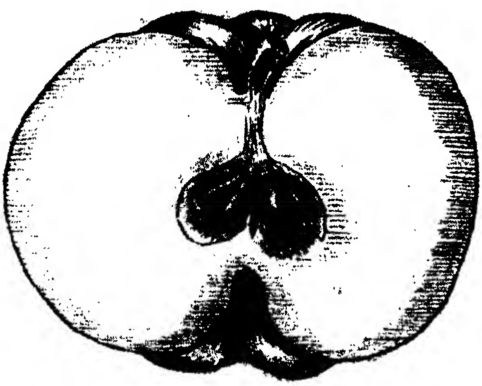


Fig. 107. Cross section of Truvor fruit (drawing by I. V. Michurin)

Fig. 108. Leaf of Truvor

Shape of fruit: nicely rounded, oblate, well-developed ribs on the fruit's surface—in general a conspicuous variety fit for display (see Fig. [107]).

Colouring: the rind is smooth, oily to the touch, yellowish green with red dashes; also striped.

Size: is the same as of the fruits of the first bearing, i.e., length 50 mm., diameter 65 mm. and weight 110 gr.

Stem: thick, short, 8 mm. long, emerges from a wide, ribbed deep cavity, lightly covered with a rough bloom.

Calyx: medium size, closed; lies in a deep, wide and ribbed basin.

Core: small as compared with the size of the fruit as a whole, with closed carpels.

Seeds: full, of good constitution, grey brown.

Flesh: yellow in colour, compact, prickly, possesses a fine spicy sour-sweet taste incomparably better than that of the Skrizhapel.

Ripening time: the fruits ripen at the end of November; in winter storage keep until April.

Properties of tree: its growth is rather vigorous; the crown's branching is dense. The resistance of the crown and of the fruit buds to our frosts is absolutely complete. Extraordinarily unexacting as regards soil, grows equally well and bears fruit both on black earth and on sandy, poor soil. The harvests alternate regularly with periods of dormancy. The shoots are of medium thickness. The leaves are of medium size, elongated-ovate with a pointed apex; the serration of the margin is small and fine.

When used as a maternal parent in crossing, the Truvor steadily transmits its best qualities as one of the best frost-resistant varieties.

This variety may be considered as second-grade for the central zone of the R.S.F.S.R.

1929

SHAMPANREN-KITAIKA[1]

(CALVILLE-KITAIKA)

The age-old Calville apple, described as far back as in the 14th century, is a white winter variety. Because of the quality of its fruits it is considered in the West as the best of all apple varieties, and in the markets of our chief cities these fruits when imported from abroad fetched higher prices than any other apples. But it is no good at all for cultivation in our orchards because of its sensitiveness to our frosts. Besides, it is greatly affected by fungi diseases, which in rainy summers affect not only its fruits but also the leaves and branches. Even in the Crimea its fruits rarely attain normal development, and they are nearly always worse than the fruits of this variety imported from France. In a word, there was no hope whatever of cultivating this delicate fruit out of doors, but, nevertheless, I had the desire to have one at least somewhat like it. For several years, therefore, I kept a specimen of a White Calville grown in a tub on a dwarf stock for hybridizing it with one of our hardy varieties.

In 1907 I fertilized a Kitaika with the pollen of the White Winter Calville mixed with the pollen of a Champagner Reinette.

[1] This variety has been described by me before under the name of Calville-Kitaika.

Germination of the seed obtained from the crossing took place in 1908. The seedling proved not quite able to withstand the winter frosts; the shoot ends of the summer's growth froze each year.

To eliminate this defect it was necessary to repeat the influence of the Kitaika apple tree, this time used as a mentor. With this in view, in 1910 buds were taken from the seedling and grafted onto the crown of the maternal tree, the Kitaika apple tree. The buds developed splendidly, covering the crown of the Kitaika. They were no longer damaged by frost.

The first bearing took place in 1913, in the sixth year of growth after germination from the seed and the fourth after the grafting.

Shape of fruit: the fruits are of a low turnip shape, medium-sized, some of them having the fine shape of the Calville, or, rather are star-shaped,

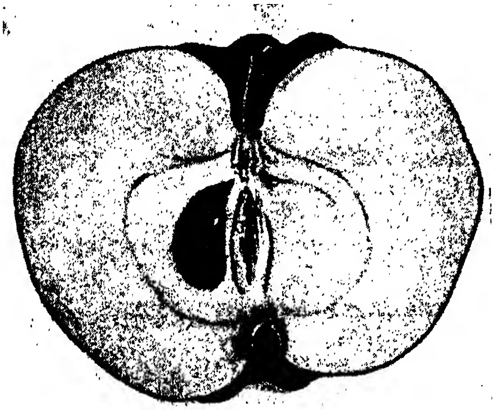


Fig. 109. Cross section of Champagner Reinette

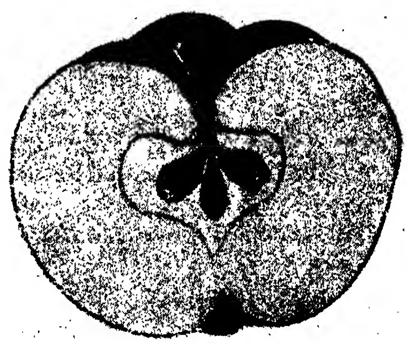


Fig. 110. Cross section of Shampanren-Kitaika

with five ribs standing out prominently down the entire length of the fruit.

Colouring: light straw.

Size: length 46 mm., diameter 66 mm., weight 90 gr.

Stem: thick, short, 11 mm. long, situated in a wide, rather deep pentahedral cavity.

Calyx: closed, rather narrow, surrounded by the source of the fruit's five ribs; situated in a shallow basin.

Core: wide, very oblate, with closed carpels.

Seeds: small, full, completely black in colour; the latter serves to indicate the hereditary transmission of the properties of the White Calville.

Flesh: compact, juicy, has the Reinette constitution rather than the Calville one; has a very pleasant sweet and slightly sour taste.

Ripening time: begins to be ripe for consumption in December; easily keeps in winter storage without spoiling until March.

Properties of tree: fully hardy; shows a squat growth with rather thick shoots of a reddish-brown colour. It requires rich soil and a site protected from strong winds, for even though the defects inherent in the White Winter Calville have been greatly lessened, some of them have nonetheless been transmitted by inheritance to the hybrid to a considerable degree, as, for example, when strong winds blow much of the fruit falls even before being completely ripe.

Then, the leaves and particularly the fruits are susceptible to attack by various parasitic fungi, the marks of whose action stand out sharply on the light colour of the fruits. Hence the main defects of this hybrid variety are the same as those possessed by its parent, the White Winter Calville, namely, the fruit's propensity to develop blemishes and to fall from the trees.

Notwithstanding the Shampanren-Kitaika's defects enumerated here, this variety should be considered a first-rate one for its excellent taste.

1929

SHAFRAN-KITAIKA

In 1907 I fertilized a Reinette d'Orléans with the pollen of an orchard Kitaika.

The seed obtained from the crossing was planted in the spring of 1908

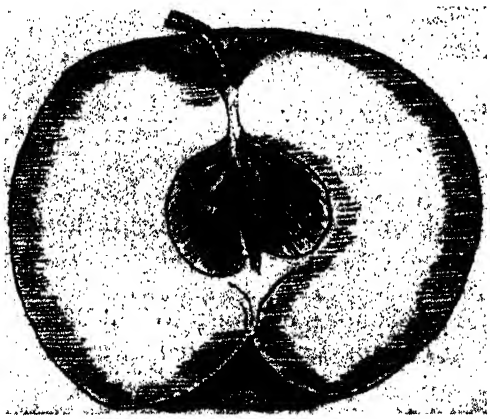


Fig. 111. Cross section of fruit of Shafran-Kitaika (drawing by I. V. Michurin)

and germinated the same spring. The seedling bore fruit for the first time in 1920, the twelfth year of its growth.

Shape of fruit: turnip-shaped.

Colouring: yellow with a dark-brown design and still darker strokes over the fruit's length on the side exposed to the sun. The Shafran-Kitaika's

Fig. 112. Harvest of Shafran-Kitaika apple trees

appearance generally greatly resembles the Reinette d'Orléans.

Size: length 45 mm., diameter 60 mm., weight 68 gr.

Stem: 20 mm. long, of medium thickness, placed in a narrow and deep cavity.

Calyx: small, closed, broad, placed in a highly slanting shallow basin.

Core: wide with slightly open carpels.

Seeds: very broad, of complete structure and dark brown in colour.

Flesh: white, friable, resembles the Calville in constitution; is juicy, has a wine-sweet taste with a slightly sour flavour and a pleasant, strong fragrance.

Ripening time: begins to ripen for use in the second half of December; the fruits keep fresh in winter storage until March.

Properties of tree: is sufficiently resistant to the winter frosts of the central zone of the R.S.F.S.R.; is of medium size; the branches are firm, of medium thickness, rather resilient, thanks to which there is practically no

Fig. 113. Leaf of Shafran-Kitaika

windfall in the summer when high winds blow or even in storms; the tree is not exacting as regards soil; the yield is yearly and astonishingly generous.

For its fine appearance, good flavour and yield this variety should be considered a first-rate one and deserving the widest commercial cultivation.

1929

SHAFRAN SEVERNY OSENNY

This variety, commercially very valuable in localities of the central and northern parts of the U.S.S.R., originated from the fertilization of the blossoms of the well-known old apple variety, Korichnoye, with the pollen

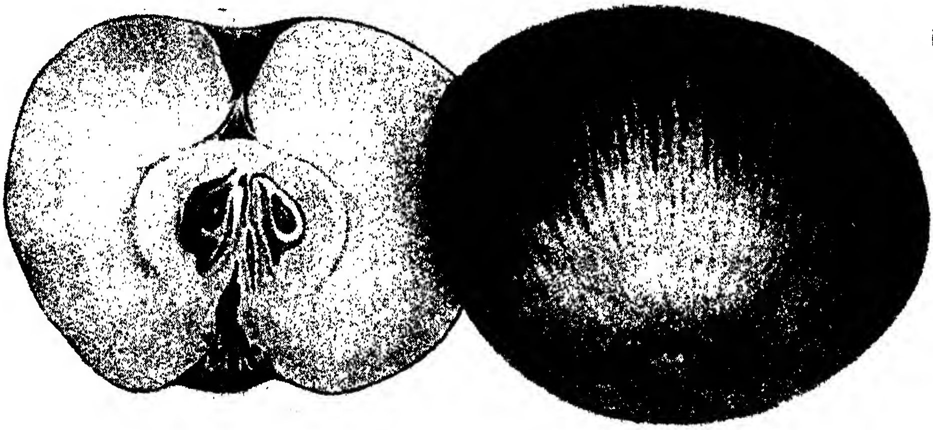


Fig. 114. Fruit of Shafran Severny Osenny

of the foreign variety, Reinette d'Orléans. Germination of the seed obtained from the crossing took place in the spring of 1895.

The first bearing took place in 1906, the seedling's twelfth year.

Shape of fruit: regular, turnip-shaped, toward the top is somewhat truncated and conic. In appearance and colouring the fruits greatly resemble the Reinette d'Orléans.

Colouring: saffron-yellowish green with scarlet strokes, thickly scattered over the entire surface of the fruit.

Size: length 55 mm., diameter 74 mm., weight 112 gr.

Stem: very short, 8 mm. long and 2-3 mm. in thickness, situated in a wide, regular, deep cavity.

Calyx: open, of medium size, placed in a wide, shallow, regular basin.

Core: very small, with closed carpels.

Seeds: ordinarily 25% are incompletely developed and 75% are full, brown in colour.

Flesh: juicy, delicate, of excellent spicy wine-sweet taste and pleasant fragrance.

Ripening time: is suitable for use early in September; keeps in storage until December.

Properties of tree: its growth is rather vigorous, compact; the tree is strong, there is little windfall in the summer; it is not attacked by insects or parasitic fungi. It is not at all exacting as regards soil; in the thirty years that I have observed the tree it has not once been damaged by winter frosts; the yield is considerable.

The variety is very valuable commercially. Its quality as to taste entitles it to be considered a first-class autumn variety for localities in the northern and central parts of the U.S.S.R.

1929

PEARS

MICHURIN BEURRÉ ZIMNAYA

In 1903, several blossoms of a young, six-year-old Ussurian pear sapling that had bloomed for the first time were fertilized with pollen taken in the orchard of an amateur gardener acquaintance of mine from a potted sample of a pear which he had erroneously called Beurré Diel. Its correct name was Beurré Royal, as became evident subsequently from the similarity between the shape of the fruit of the hybrid and that of the Royal pear.

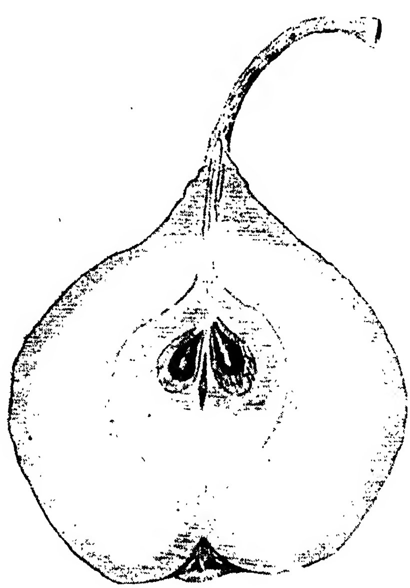


Fig. 115. Michurin Beurré Zimnaya, first bearing (drawing by I. V. Michurin)

The young Ussurian pear sapling that had bloomed for the first time was chosen here for the role of the maternal plant because trees of wild varieties of older age, on being crossed with cultivated varieties, display excessive vigour in transmitting their characters to the hybrids; in the case of young plants grown from seeds, however, this influence on the hybrids is considerably weaker.

The shoots thus obtained in the spring of 1904, and five hybrid saplings grown from them later, showed the following results. In 1911, two seedlings produced

small, tasteless fruit of summer ripening, their stems suffered greatly from sunburn.

In 1912, the third seedling, distinguished for its exceptionally thick shoots, and therefore named Tolstobezhka, produced beautiful fruit of good flavour which kept in storage until January; but the qualities of this variety of fruit—both flavour and storage quality—developed only gradually in subsequent years. The fourth seedling, in 1912, produced first fruits of large size, thickly speckled with red patches on a green background, of good flavour, and autumn ripening, which I named Rakovka. The fifth seedling, which I named Michurin Beurré Zimnaya, successfully combined, both in the properties of the tree and in the quality of its fruit, the virtues of both parent plants, in the same combination, thanks to which this new variety of real winter pear will undoubtedly be evaluated as first-grade, very good for orchards in the central and partly also in the northern zones of the U.S.S.R. This high evaluation of this variety is not in the least an exaggeration, if only for the reason that in our parts there has not been up till now a single hardy variety of pear, the fruit of which could keep fresh during the winter.

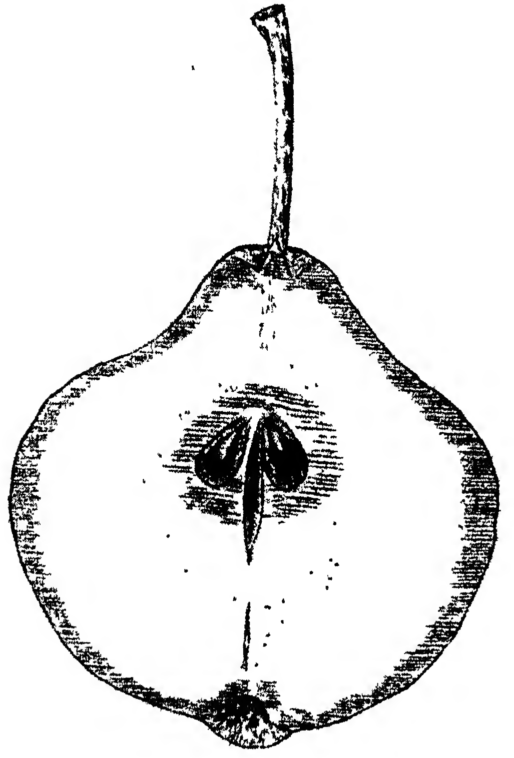


Fig. 116. Michurin Beurré Zimnaya, second bearing (drawing by I. V. Michurin)

Moreover, of enormous importance is the exceptional hardiness of the tree. During my twenty-two years of observation, not a single branch, not a single twig, was damaged by frost. The tree of this variety suffered no particular damage even in the winter of 1926/27, when the temperature went down to 36°C. below zero, and its stem suffered no damage whatever from sunburn. Furthermore, the fruit and leaves suffered scarcely any damage either from insects or from parasitic fungi, and therefore, the fruit has a neat exterior and looks beautiful.

The yield is very abundant, and in addition to all this, the flavour of the

Table IV. Michurin Beurré Zimnaya with parent plants:
right—Michurin Beurré Zimnaya; upper left—wild Ussurian pear (mother); below—Beurré Royal (father)

fruit of this variety can, in my opinion, be regarded as equal to that of many southern dessert varieties of pears.

The first bearing took place in 1914, in the eleventh year of growth; the sapling produced as many as twenty-five fruits, the weight of the big ones reaching only 107 grams.

In the second year of bearing, in 1915, simultaneously with the blooming of the local varieties, such as, for example, Tonkovetka, Tsarskaya, and others, large white blossoms of the new variety completely covered half of the branches of the young crown of the sapling (there were no blossoms on the other branches) and all without exception set fruit; moreover, there were no windfalls whatever right up to the time the fruit was picked in the middle of September. The fruit held very firmly to the branches and well withstood the action of strong winds. The lower, more horizontally disposed branches, were weighted to the ground by the thick clusters of fruit.

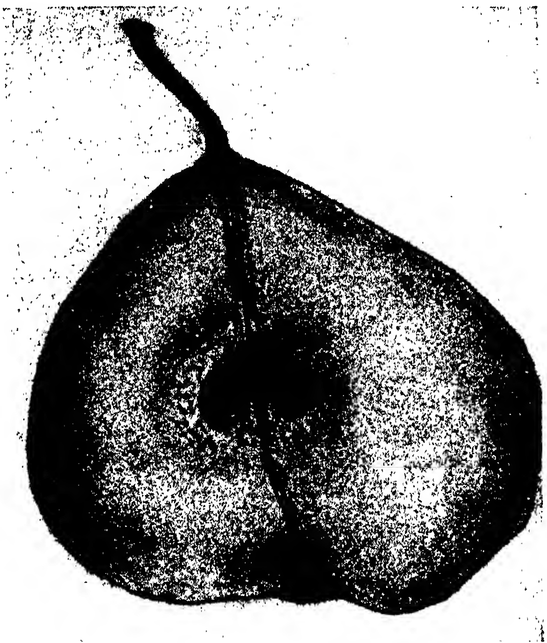


Fig. 117. Cross section of fruit of Michurin Beurré Zimnaya (reduced)

At the second harvest—September 28, 1915—150 fruits were picked, and the largest of these already weighed as much as 171 gr.; the total weight of the whole crop was 22 kg.

The height of the young tree in 1915 was 4 m. The width of the wide-panicular crown was 3 m. Height of stem 1.35 m., thickness at its base 10 cm. in diameter.

The leaves, of medium size, keep on the tree until the end of the autumn, much longer than those of the local varieties. In storage, the fruit is very resistant to decay, even in those cases when the skin is damaged by deep scars. Nor does it wrinkle when stored in very dry premises.

In the spring of 1916, Michurin Beurré Zimnaya began to bloom after the Ussurian pear and the summer local varieties; during the blooming period there were three snaps of frost, one after another, when the temperature went down to 3°C. below zero, but this had no harmful effects on the setting of the fruit of this variety; there were no seeds in the fruit that year, however. The fruit was picked at the end of September. In storage it began to turn yellow on November 10. Half the crop kept until the beginning of February, the rest kept until the beginning of March 1917.

The weight of the fruit was about 128 gr., although it had not diminished in external size; it follows then that the flesh of the fruit was of a looser structure that year and totally bereft of seeds.

Already in 1915 I noticed that the fruits of this variety that were picked late, namely, at the beginning of October, kept in storage only until January, i.e., six weeks less than the other fruits that were picked at the end of September. In 1916, when there was a rainy and cold summer, the fruit picked

Fig. 118. Pear orchard of Michurin Beurré Zimnaya at reproduction department of Central Genetics Laboratory

on September 23 kept in storage until April, but in 1917 (when there was a hot, dry summer and an exceptionally early spring), the fruit that was picked on October 1, kept only until the end of October and went bad, beginning to decay not on the outside, and not in the core, but in patches in the middle stratum of the flesh. Here it must be taken into consideration that in the spring of that year weevils damaged all the blossoms of this pear without exception, and although, in spite of this, the fruits, nevertheless, set and grew, they had no seeds, as was the case in 1916; it is very probable that this damage also affected the storage quality of the fruit.

Here, the phenomenon of parthenocarpy, or the development of fruit without fertilization, also serves as a good quality of the variety, because in the years when the blossoms are damaged by frost or insects a good crop of fruit is nevertheless obtained from the trees, although in such cases it loses considerably in storage quality.

Fig. 119. Harvest of Michurin Beurré Zimnaya pears

Fig. 120. Yield of Michurin Beurré Zimnaya

I now pass to the pomological description of *the crops of recent years*.

Shape of fruit: broad pear shaped, asymmetric.

Colouring: at the time of picking, October 1—pale green, speckled with small grey patches. During winter storage, approximately towards November-December, the fruit acquires a pure yellow colour with a brownish-carmine flush.

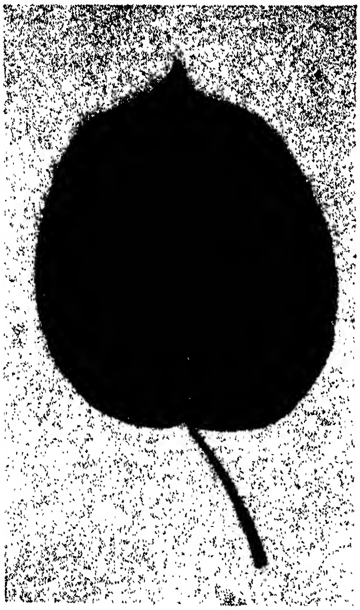


Fig. 121. Leaf of Michurin Beurré Zimnaya

Size: length 75 mm., diameter 85 mm., weight 271 gr.

Stem: thick, 27 mm. long, thickens at the base; of brown colour, at the junction with the fruit it has weak ringlike excrescences, lodged in a narrow, 3 mm. cavity.

Calyx: rather broad, open or half-open, lodged in a shallow basin.

Core: small compared with the size of the fruit, with closed carpels.

Seeds: well developed, fully ripened, dark-brown colour.

Flesh: white in colour, juicy, oily, sweet, non-viscous, without tartness and of strong fragrance.

Ripening time: the fruit is picked from the tree at the end of September, begins to ripen at the beginning of December; it keeps in winter storage until March without losing its excellent flavour.

Properties of tree: abundant crops, hardiness complete, blossoms very resistant to morning frost, and even with the strongest morning frost, when the outside parts of the blossoms are killed, ovaries are nevertheless formed and seedless fruit is produced. The same occurs when the blossoms are damaged by weevils, but in such cases the fruit loses its long winter storage quality.

The leaves of the Michurin Beurré Zimnaya do not fall until the late autumn. If subjected to mechanical damage the fruit does not rot, the damaged part becomes covered by a corky tissue which prevents fungi from reaching the pulp.

From a letter received on February 15, 1923, from an amateur gardener Nikolai Yosifovich Dianov, who lives in the village of Yashkino, Berezovsky District, Ivanovo Region, it is evident that the Michurin Beurré Zimnaya pear, purchased in the nursery in 1916 and planted late in the autumn, from 1917 to 1922 grew well and proved to be completely resistant to frost through all the six years.

And yet that locality is situated near the 58° N. Lat. and five hundred

kilometres north of the town of Michurinsk. In that locality, owing to the smaller total of summer heat and, in general, the shorter vegetative period, the fruit will ripen in storage later and keep fresh until May, as has been observed also in Michurinsk in cold years. Owing to the fact that the Michurin Beurré Zimnaya variety is unrivalled for its splendid flavour, long winter

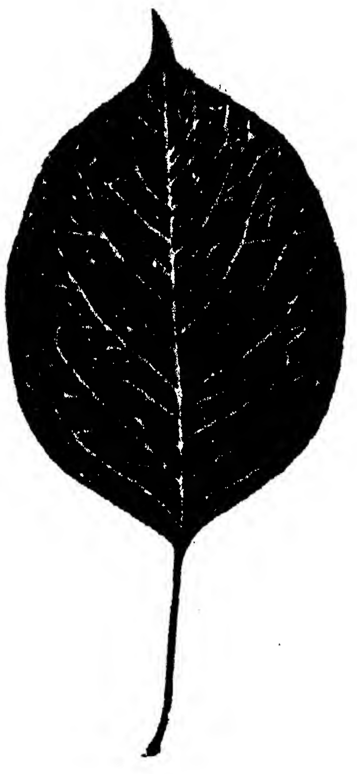


Fig. 122. Leaf of Beurré Royal pear

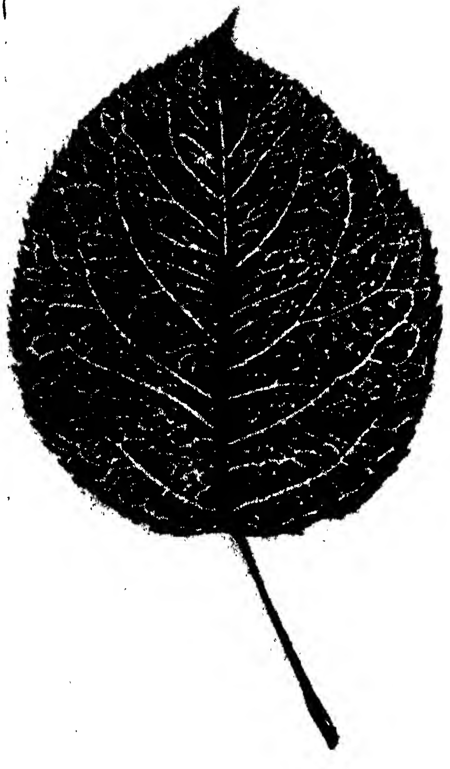


Fig. 123. Leaf of Ussurian pear

storage qualities and the remarkable firmness of the fruit in autumn, which enables it to be transported long distances without harm, it is suitable not only for the central and parts of the northern zones of the U.S.S.R. but also for some western and more southern localities.

This variety must be fully regarded as first-grade and of high productive value, particularly if it is grafted high up on the stem of a wilding.

1929

BEURRÉ KOZLOVSKAYA

This new variety was obtained in 1889 by the fertilization of the old Tonkovetka variety with the pollen of the winter variety Beurré Diel.

The seeds obtained from this cross sprouted in the spring of 1890.

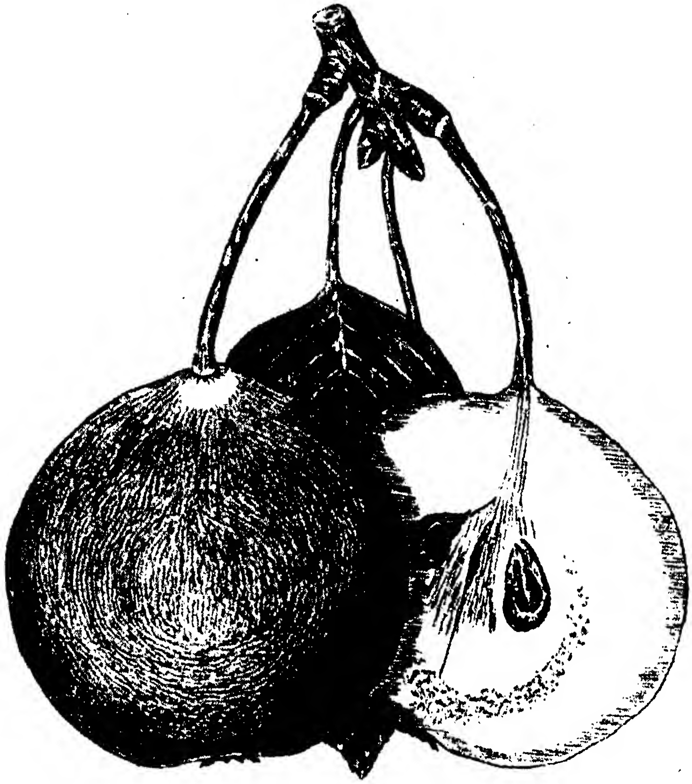


Fig. 124. Fruits of Beurré Kozlovskaya pear (drawing by I. V. Michurin)

The first bearing occurred in 1898, in the ninth year of the seedling's growth.

When the fruit ripened it was found that the characters of the old Tonkovetka variety formed in the course of centuries under the influence of the environment of the given locality, proved to be dominant in relation to the characters of the Beurré Diel. As a consequence, the fruit of the new hybrid, Beurré Kozlovskaya, although possessing higher intrinsic qualities as compared with the Tonkovetka variety, turned out to be, like the mother plant, of summer ripening, and small in size.

Shape of fruit: round, Bergamotte-like, slightly flattened at the calyx.
Colouring: light green, passing to yellowish green at the time of ripening.
Size: length 50 mm., diameter 51 mm., weight 92 gr.

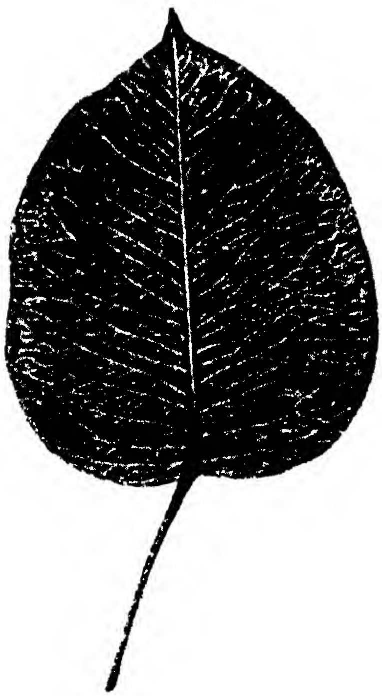


Fig. 125. Leaf of Beurré Kozlovskaya pear

Stem: medium thickness, 37 mm. long; cavity in which stem is placed barely perceptible, or completely absent.

Calyx: of small dimensions, open; placed in a very wide, sloping, slight basin.

Core: medium size, asymmetrical, closed carpels.

Seeds: full, sharp pointed, medium size, dark-brown colour.

Flesh: juicy, melting, spicy sweet flavour.

Ripening time: becomes fit for consumption in the first half of August.

Properties of tree: this variety is distinguished for its absolutely complete hardiness and extraordinary fertility. The fruit in clusters, sometimes nine together, cover the branches which, possessing a firm, resilient wood, stand

up so well to winds and storms that breakages in the crown in the course of the summer are never observed; growth of the Beurré Kozlovskaya tree is sturdy.

For its fine flavour, early ripening of fruit and abundant crops, this variety must be regarded as second-grade for places situated near industrial centres and cities.

1929

BEURRÉ POBEDA

Having set myself the task of increasing the number of new winter varieties of pears for localities in the central and northern parts of the U.S.S.R., I, in 1904, fertilized the blossoms of a Tsarskaya pear with the pollen of a French variety of pear, the Saint-Germain.

The seeds obtained from the crossing sprouted in the spring of 1905.

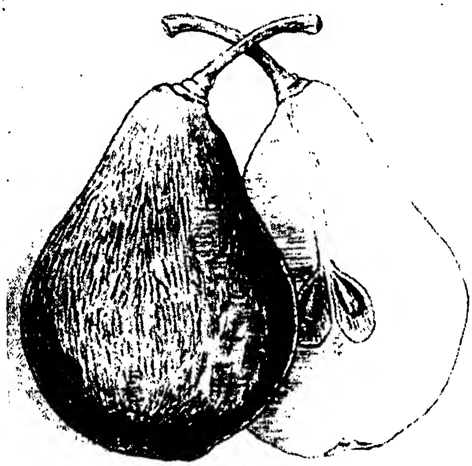


Fig. 126. Beurré Pobeda, first bearing
(drawing by I. V. Michurin)

The first bearing occurred in 1916, in the twelfth year of growth of the seedling.

The fruit of the fifth crop of the Beurré Pobeda, in 1920, on the maternal tree, in the very dry and hot summer of that year, picked two weeks earlier than the normal date, i.e., September 20, fully ripened in storage by October 30.

In the spring of 1919 buds of the Beurré Pobeda were grafted to the crown of an adult Bergamotte seedling which was already bearing, and also on to two other adult seedlings of a wild species; in 1922, one of the grafted

trees bore fruit of a size only slightly larger than fruit of a first bearing. By 1926, the fruit of the Beurré Pobeda had gradually almost doubled in weight and its storage period lengthened to February-March.

Shape of fruit: true pear-shaped, sometimes a little asymmetrical, spherically rounded at the calyx, narrowing at the stem.

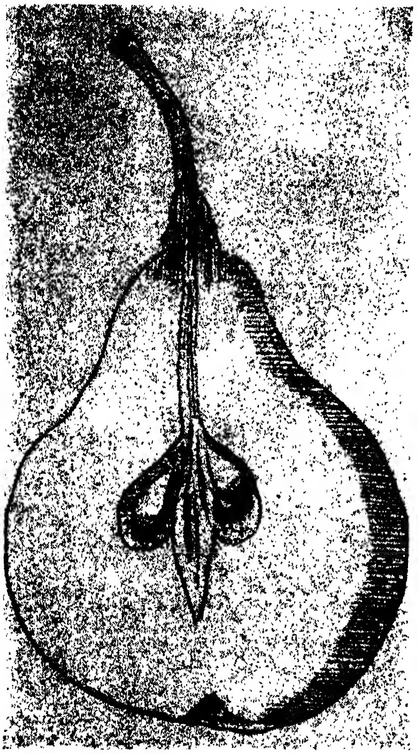


Fig. 127. Beurré Pobeda, fifth bearing (drawing by I. V. Michurin)

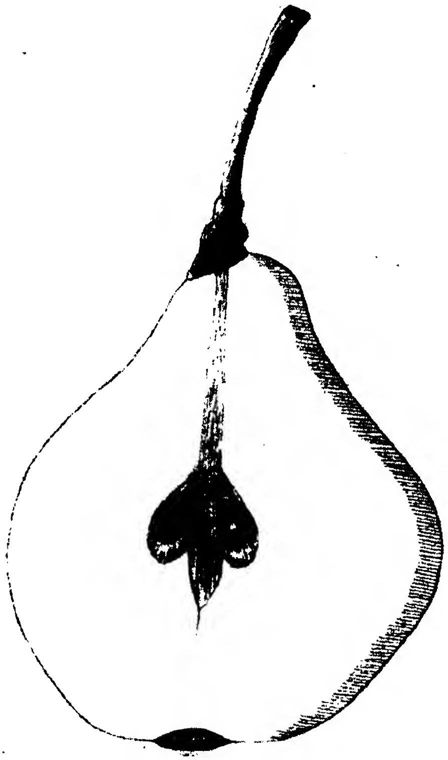


Fig. 128. Fruit of Beurré Pobeda (drawing by I. V. Michurin)

Colouring: bright yellow with a pink flush on the whole of the sunny side and broad patches of leathery bloom.

Size: length 85 mm., diameter 74 mm., weight 172 gr.

Stem: length 45 mm., medium thickness; joins with the fruit in ringlike excrescences of a fleshy composition.

Calyx: open, placed in a shallow, slightly ribbed basin.

Core: narrow in shape with closed carpels.

Seeds: medium size, full, light-brown colour.

Flesh: very juicy, melting, no signs of granulation, no tartness whatever, pleasant sweet flavour.

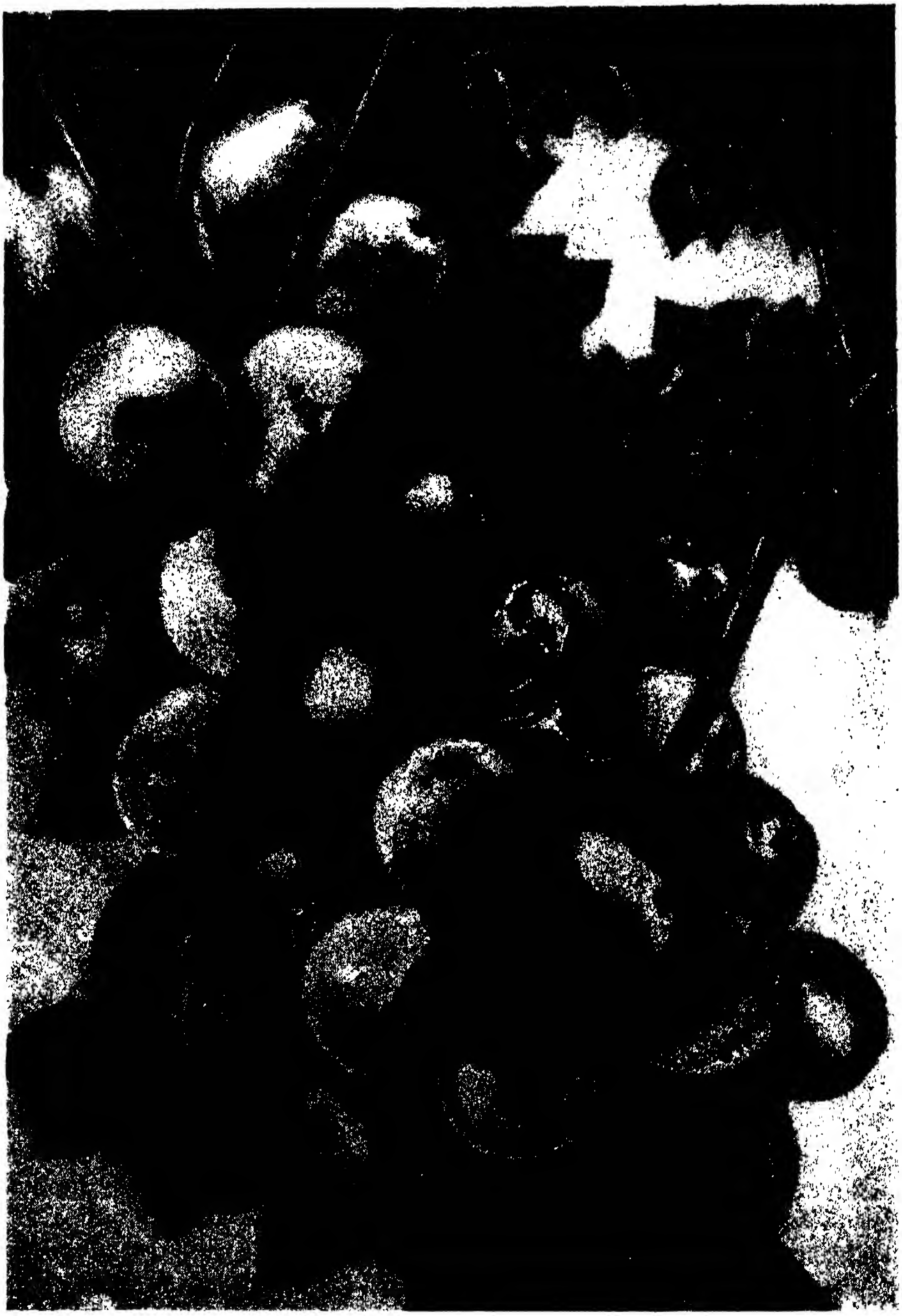


Fig. 129. Yield of Beurré Pobeda pear trees

Ripening time: begins to acquire consumption ripeness at the end of November; under good storage conditions can keep until February-March without losing any of its splendid flavour.

Properties of tree: medium growth, crown of pyramidal shape.

Fairly good resistance to winter frosts: during twenty years of my observation the branches and shoots suffered little from frost; the leaves, of medium size, fall by October 20, about three weeks later than those of the old local varieties.

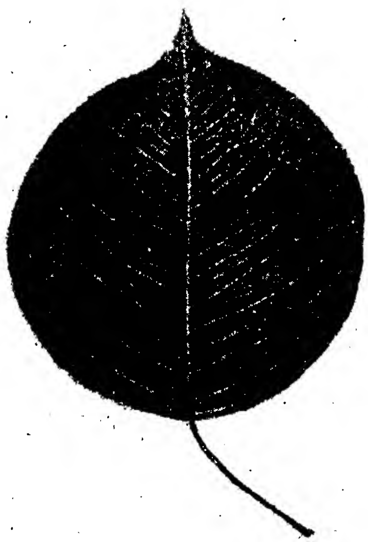


Fig. 130. Leaf of Beurré Pobeda

The tree grows in dry and poor, sandy soil; consequently, if grown in good clayey soil and with sufficient moisture the fruit gains much in flavour and size.

Owing to its highly valuable flavour and its ability to keep long in winter storage, this variety is fully first grade and very remunerative for the central zone of the U.S.S.R.

1929

VEGETATIVNAYA

In addition to the varieties described above, I find it absolutely necessary to give an account of an interesting variety of pear that has been found in the mountains of North Caucasus.

The Vegetativnaya pear is a matter of outstanding world interest because in the course of the vegetative period it produces three crops—two by sexual means and one by vegetative means, which is never observed in other perennial fruit plants.

In the summer of 1931 I sent my immediate assistant, Pavel Nikanorovich Yakovlev, who has thoroughly studied and fully understands the work of hybridization, to get this pear, and soon after he brought me all the material and precise information, collected where this pear was found—in the mountains of North Caucasus—that interested me.

It was ascertained that in the spring, like all other varieties, this pear blooms and bears fruit of medium size and of fairly good flavour. After the

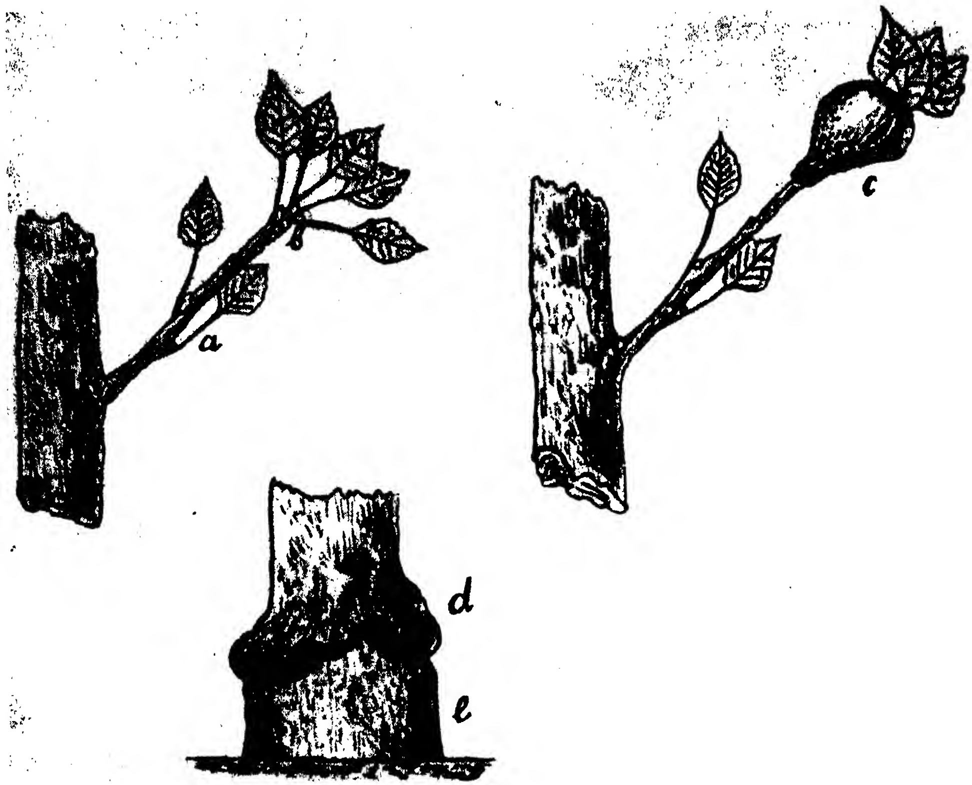


Fig. 131. The Vegetativnaya pear tree:
a) one-year-old shoot; b) tip of one-year-old shoot with group of leaves from whose stalks a vegetative pear is formed; c) vegetative fruit with rosette of remaining leaves in upper hollow; d) lower part of trunk of scion; e) excrescence on stock

fruit ripens, in the first half of July, the tree blooms a second time and, simultaneously, the buds on the young shoot give rise to small stalklike formations which, in their turn, bear several buds at the tips crowded close together; from these buds leaves begin to develop.

As these leaves grow, their petioles gradually and simultaneously begin to swell, and by the end of August and beginning of September, when the pears from the second blooming are already ripening, the fruit that was

formed vegetatively from the petioles also acquires pear shape; and by this time the petioles are quite imperceptible, because it was from their simultaneous thickening on the fruit stalks that these fine pears, which for size and flavour cannot be distinguished from fruit that had set at blossoming, were formed.

The leaf blades of the petioles from which the "asexual" pears are formed do not disappear like the stalks; they remain in the place of the calyx, gracefully protruding from the top of the vegetative fruit in the form of a large bunch of rosettes (see Fig. [131]).

A detailed inspection of the garden where this pear grows revealed that there were two specimens of this variety of pear at the place and both proved to be grafted, the scion looking somewhat thinner than the stock and having a large excrescence above the latter (such an excrescence is often found on grafted varieties of fruit trees which have a stock of an alien species).

In addition to cuttings from this vegetative pear, roots were also taken for the purpose of ascertaining the species of the stock on which this pear had been grafted, for the possibility was not precluded that all this mix-up in fruit bearing was due to the influence of the stock.

The cuttings from this exceptionally interesting pear were grafted on August 11, 1931, in our chief scientific department [the Plant-Breeding and Genetics Station], on to different species of stock: apple, pear, quince, mountain ash, service tree and hawthorn.

The excellent way in which the buds took to all kinds of stocks, which became evident already in September, reveals the enormous plasticity and adaptability of this pear in respect to joining easily with remote species.

It may be hoped that the Vegetativnaya pear will, in its turn, either by planting, or by hybridization with other, cultivated varieties of pears and with other species and genera of fruit plants, produce a number of excellent varieties that will be capable of bringing about a great improvement in socialist fruit growing.

The bulletins on the work of the experimental station will give reports on the results of the experiments made with the Vegetativnaya pear, and, in particular, on the correlative influence upon it of different species of stocks.

1932

RUSSKAYA MOLDAVKA

This new hybrid variety was obtained from the seeds of the oldest Russian variety of pear, known in the former Tula Province by the name of Tsarskaya, the blossoms of which were fertilized in 1901 with pollen from the pear known as the Moldavskaya Krasnaya, or Malikovka. The seeds obtained from the crossing sprouted in the spring of 1902.

The first bearing occurred in 1910, in the ninth year of growth.

Influenced by the small-fruit pear Tsarskaya (a variety which probably originated directly from the wild-growing varieties even earlier than the seventeenth century), the first fruits were very small, but later, in the course

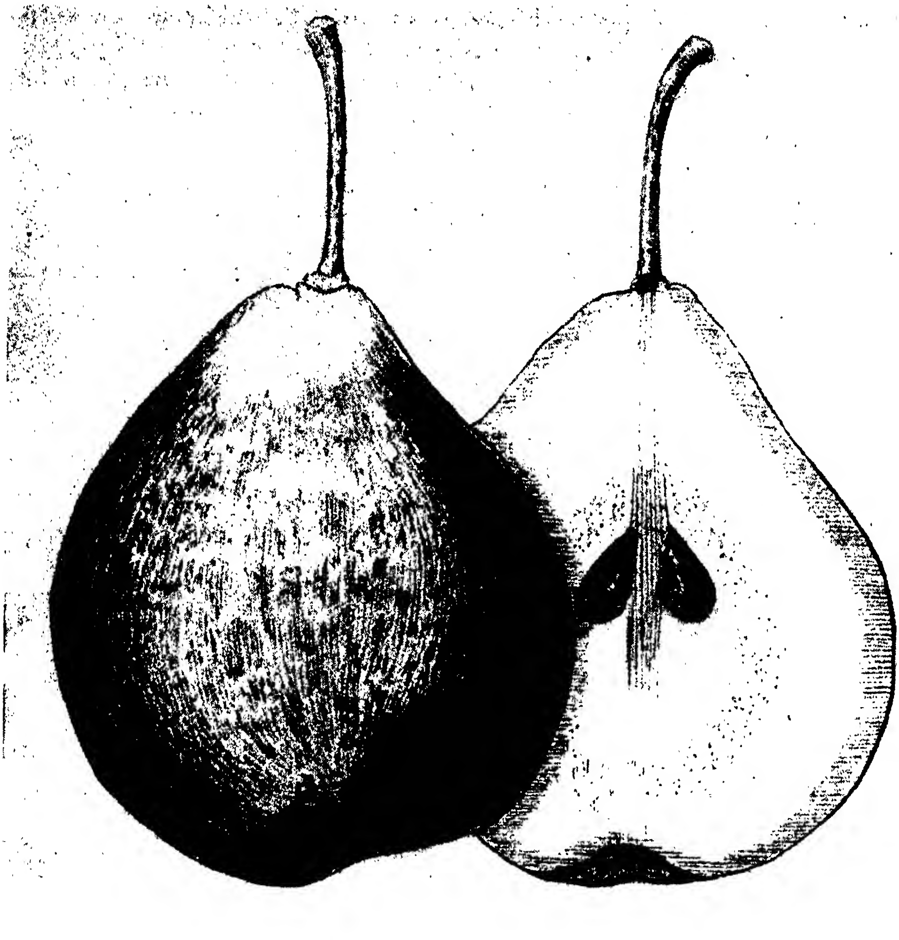


Fig. 132. Fruit of Russkaya Moldavka (drawing by I. V. Michurin)

of fifteen years, they gradually increased to the size, an idea of which can be obtained from Fig. [132] (fruit of the 1925 crop), and the flavour of their pulp also improved considerably.

Shape of fruit: peg-top shape.

Colouring: light green with a slight red flush on the sunny side and small darker spots over the whole surface.

Size: length 64 mm., diameter 58 mm., weight 93 gr.

Stem: thin, 40 mm. long, slightly thickened near the fruit, in most cases

has no cavity, but when such do occur, they are too small and narrow.

Calyx: open, with very prominent sepals, placed in a very shallow, sloping basin.

Core: with closed carpels, empty in the middle, as is characteristic of the Malikovka and of all Malikovka hybrids.

Seeds: large, fully developed, dark brown, produce a cultivated type of seedlings.

Flesh: juicy, sweet, large-grained, slightly crisp, small granulations, sweet flavour.

Ripening time: October.

Properties of tree: branches do not suffer from frost; not exacting as regards soil. This variety is more suitable for the central regions of the U.S.S.R. than the paternal plant, i.e., the Malikovka, both as regards hardiness and longer storage period; it keeps until the end of October, whereas the genuine Malikovka, every year, begins to spoil about three weeks and sometimes even a month earlier than Russkaya Moldavka. This is very important in respect to marketing the fruit. It must be assumed that if this variety is trained not on a sandy soil its fruit will greatly improve both in size and flavour.

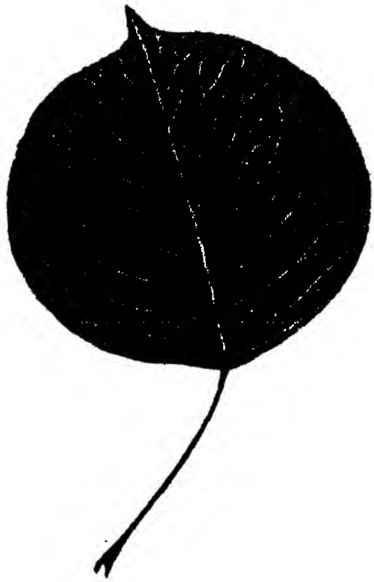


Fig. 133. Leaf of Russkaya Moldavka

This variety is suitable for drying and pickling.

For more northern localities, this variety is second grade.

1929

SURROGAT SAKHARA

This is a splendid hybrid from the seeds of a Tsarskaya pear that was fertilized in 1905 with the pollen of an American Idaho pear.

The seeds obtained from the crossing sprouted in the spring of 1906.

The first bearing of the seedling occurred in 1915, in the tenth year of its growth.

The seedling of this hybrid grew up under quite exceptional conditions. It was given a soil of artificial composition: the place chosen for it had a deep layer of river alluvial peaty clay, to every 2 m.^{2} of which were added 2 kg. of unslaked lime, 6 kg. of horn sawdust and 128 gr. of sodium nitrate. Then, every year, early in the spring, the soil was watered with a solution of guano (pigeon) with an addition of unslaked lime.

A week after the soil was watered it was loosened to a considerable depth and its surface was covered with a layer of hotbed dung 5 cm. thick.

In addition, in the course of five years, beginning with the first year of growth, there was annually injected under the bark (into the outer layer of wood with the aid of a Pravatz hypodermic syringe attached to a

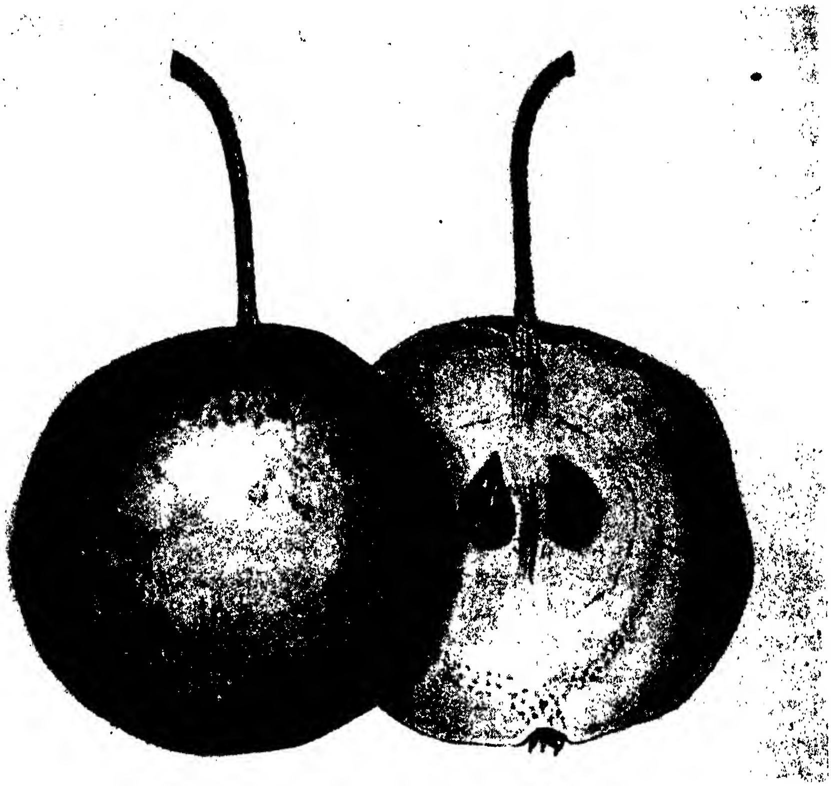


Fig. 134. Fruit of Surrogat Sakhara pear tree

rubber tube and an upturned bottle) a 14% solution of sugar in gradually increasing quantities commencing with 3 $cm.^3$ for the first year. This training regime was adopted in order to ascertain what influence increased nutrition had upon the formation of the structure of the hybrid seedlings. It transpired that this nutrition does not in the least expedite the initiation of fruiting and does not increase the size of the fruit; nor was any particular deviation in the structure of the seedlings in the direction of cultivated forms observed; evidently, the injection of the sugar solution only helped to increase the percentage of the sugar content of the pulp of the fruit.

In the summer of 1919 an experiment was made in squeezing out the juice of one of the fruits (weight 128 gr.). The squeezing was performed by

screwing the crushed fruit in a piece of linen. The juice obtained was boiled for half an hour on a slow fire and 13 gr. of glucose was obtained in the form of a thick syrup (thicker than honey) with a strong confectionery fragrance; sugariness was equal to, or even slightly above, the sweetness of honey. The syrup obtained kept for a long time without spoiling and no fermentation was observed for a month. Observations from 1923 to 1926 showed that seedlings grown from seeds taken from the fruit of an own-rooted maternal tree of this variety, in most cases produce plants with the characters of cultivated varieties in different variations more or less close to the form of the nearest kin.

Fig. 135. Leaf of Surrogat Sakhara

Shape of fruit: round, Bergamotte-like, not ribbed, but with slight protuberances on surface, sometimes the protuberances are prominent.

Colouring: when picked, green with yellow tint; flush on sunny side, dull brick-red, diffused, and covers about one-fourth of the surface of the underside; when ripe the colour remains almost unchanged, except that it becomes somewhat paler and the yellow tint becomes deeper. Skin rather thin but compact and possesses a specific, strongly expressed spicy fragrance.

Size: length 65 mm., diameter 70 mm., weight 137 gr.

Stem: very long, up to 48 mm., rather thick, compact, woody, sparsely covered with warts, pale greenish-yellow, reddish-yellow on the sunny side, cavity small, of regular, sloping cone shape.

Calyx: open, rather large. Shape, sometimes round, sometimes flattened at sides; basin very small, round or wide oval, with prominent protuberances, sometimes the basin is completely absent; bases of sepals rather widely separated from each other; they are wide and short in shape, of dark-red colour, the stamens are preserved among the sepals, pubescence of the sepals slight.

Core: medium size, situated away from the centre a little nearer to the calyx, broad and spindle-shaped; the carpels closed, elongated-ovate, carpel walls quite smooth; core distinguished for almost complete absence of hard parts except for the seeds.

Seeds: of medium size, elongated-ovate, well developed, light brown in colour.

Flesh: marble white with greenish tint, particularly near skin, exceedingly juicy, small-grained, tender, fragile, characterized by complete absence of granulation; pure sweet flavour with peculiar, specific aftertaste.

Ripening time: end of August, beginning of September; the fruit can keep two weeks.

Properties of tree: distinguished for sturdy growth, the bark of the young trees of rare unique colour—glistening dark brown, resembling the bark of the cherry tree; produces a very good crop, but not sufficiently hardy. The fruit of the Surrogat Sakhara, when dried, produces a material which for its flavour and fragrance is more like preserved than dried pears. A distinguished, first-grade, dessert variety.

1929

TOLSTOBEZHKA

The Tolstobezhka, the sister of the Michurin Beurré Zimnaya, was produced from a seed of the Ussurian pear that was fertilized in 1903 with pollen from the Beurré Royal.

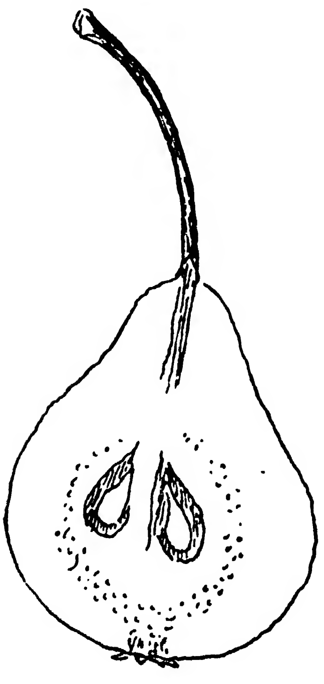


Fig. 136. Tolstobezhka from a grafted adult wild pear tree (drawing by I. V. Michurin)

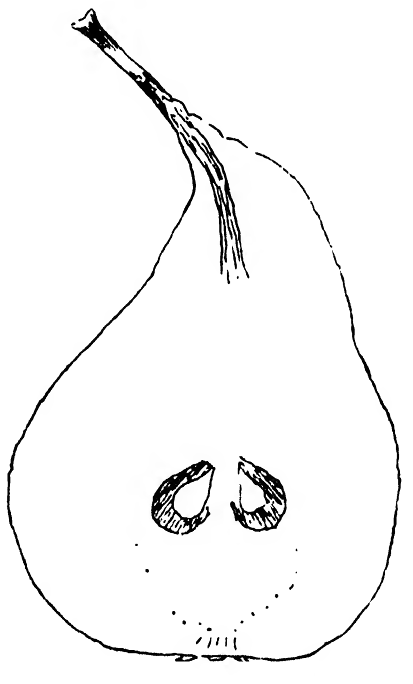


Fig. 137. Tolstobezhka of first harvest grafted on Tonkovetka (drawing by I. V. Michurin)

The seed that was obtained from the crossing sprouted in the spring of 1904.

The first bearing occurred in 1915, in the twelfth year of its growth.

In 1909, before the seedling began to bear, buds from the maternal tree of the Beurré Tolstobezhka were grafted on the crown of an adult Tonkovetka tree and on that of an adult wilding.

The budded Tonkovetka bore its first fruit in the third year, in 1912, weighing 78 gr., and in the following year the weight of the fruit increased to 131 gr. The budded wilding, however, produced small fruits, although also of winter ripening, but with a large quantity of hard granulation. The illustrations [Figs. 136, 137, 138 and 139] show the already extremely sharp influence of the stock on the hybrid's fruits, the hybrid being grafted on the stock when still young. These fruits proved to be entirely different from those of the maternal tree that was left on its own roots.

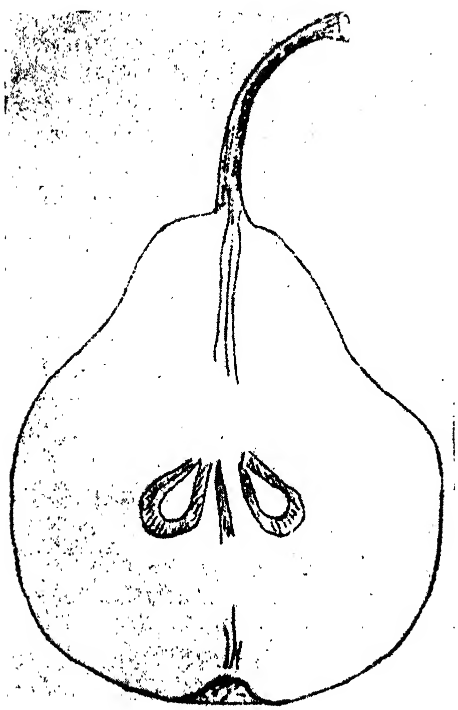


Fig. 138. Tolstobezhka of second harvest grafted on Tonkovetka (drawing by I. V. Michurin)

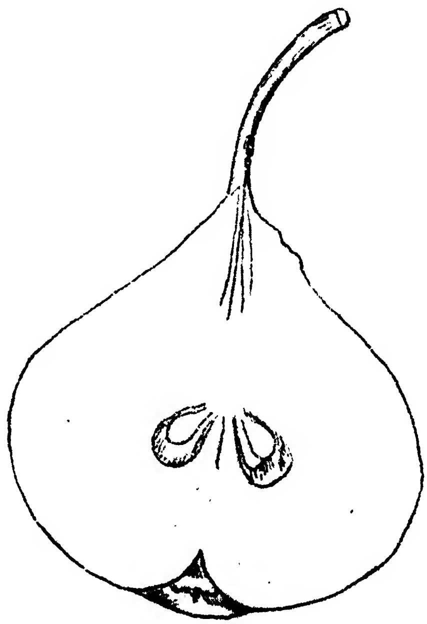


Fig. 139. Fruit of Tolstobezhka (reduced drawing by I. V. Michurin)

Shape of fruit: variable, most often of round, broad-bell shape, tapering at the foot where the protuberances are rather prominent.

Colouring: when picked, light green, during winter storage fruit acquires a yellowish tint; surface of fruit covered with small, greenish spots.

Size: length 67 mm., diameter 65 mm., weight 125 gr.

Stem: medium thickness, length 32 mm., cavity always absent.

Calyx: medium size, half open, very broad, situated in shallow basin.

Core: small with closed carpels.

Seeds: medium size, well developed, dark-brown colour.

Flesh: white, juicy, sweet, no granulation whatever.

Ripening time: begins to ripen for consumption at end of November. In winter storage under good conditions fruit can keep until February without losing its flavour.

Properties of tree: fully resistant to frost, generous crops; not exacting as regards soil, not subject to attack by fungi parasites. For fine flavour, long winter storage and good transportation qualities is a first-grade variety.

1929

QUINCE
SEVERNAYA

In the northern localities of our Union an important role can be played by the cultivation of low, dwarf, fruit trees, even if of the simple bush type, which requires less care and attention than other trained varieties.

For the cultivation of trees of such types, species of fruit-plant dwarfing stock that are needed must be specially raised for this purpose.

Every nursery in the northern regions ought to have this dwarfing stock and propagate it on its grounds, since it is impossible to obtain such stock material from any of the nurseries in the South. Firstly, the southern varieties of dwarfing stock will be unsuitable because they lack resistance to the frosts of the North, and secondly, nobody in any of the nurseries in the central and southern parts of our country (excepting my chief hybridization department in the town of Michurinsk) has as yet even thought of raising hardy species of such stock.

For pomes the dwarfing stock needed is a Paradise or quince obtained by layerage, or by cutting propagation, for only stocks obtained in this way fully answer the demands put upon them, i.e., to give squat growth of the bush types to cultivated varieties that have been grafted on them.

Dwarfing stock obtained from seed, however, produce not a dwarf growth of the varieties that have been grafted on them, but a taller one.

But up till now we have not had dwarfing stock, either for apples or for pears, suitable for the northern regions, and besides, nobody has started on the work of raising such hardy stock.

Here I will report the results of the work I myself have done in raising precisely hardy species of dwarfing stock. This work, at first sight not exceptionally important, I conducted in the course of fifty years alongside with my main task of raising new local varieties of fruit plants of improved quality. The difficulties connected with the fulfilment of such a task may be

judged from the one fact alone that only now, in the last years of more than a half a century's work, have I been able, at last, to see successful results of my labour.

It is common knowledge that the various strains of quince that grow in the northern parts of the former Central Black-Earth Region are not sufficiently hardy. Nearly every year the aerial parts of these plants freeze at the snow line, and in winters when there is little snow and early severe frost, even the roots of the quince often freeze if they are not protected by a layer of manure already in the autumn. Moreover, in all nurseries, both in Central and Southern Russia, all the strains of quince that are used as stock for the training of pears, imperatively demand a sufficiently moist soil. In our sharply continental dry localities, however, there is very often a shortage of moisture for quinces, which, of course, harmfully affects the development of the cultivated varieties of pears grafted on such stock.

All this induced me to start raising a strain of quince stock more suitable for our needs. To fulfil this task I procured several specimens of wild mountain Caucasian quince as a species that needs moist soil less than others and, in addition, possesses relatively more resistance to the rather severe frosts in the mountains of the Caucasus. In 1891, I fertilized the blossoms of this species of quince (*Cydonia oblonga Mill.*) with the pollen of the *Cydonia vulgaris Pers.*, a semicultivated variety obtained from Sarepta. From among the hybrid seedlings, raised in sandy, dry soil, two specimens were chosen for their resistance to frost and hardiness in a dry location.

Then, in later times, the seedlings were reared in the course of three generations by selection from the maternal plants for resistance to dry location and to the frost in the former Central Black-Earth Region. In the exceptionally severe winter of 1928/29, although the tips of the shoots of the aerial parts of the grown trees were damaged and the trees produced no fruit in the following summer, the young, two- or three-year-old, seedlings excellently weathered these fierce and lengthy periods of frost, the like of which we had not experienced in our parts for a long time.

Because of its frost-resisting qualities and of its ability to stand the climate of the northern zone of the R.S.F.S.R. in general, I named this new variety Severnaya quince.

Planted from cuttings early in the spring, Severnaya quince easily takes root in an ordinary plot in the open, and still more reliably, in a cold frame under glass. This variety of quince readily takes to budding with cultivated varieties of pears and in spite of the rather dry, sandy nature of the soil in the nursery we rear stoutly developed budded trees of squat growth, and on half the hybrid varieties of pears the size of the fruit is increasing considerably and their flavour is being perceptibly improved.

Shape of fruit of the new variety of quince: truncated cone shape; at the calyx the fruit is sometimes egg-shaped and even quite round—in general, the shape varies and the surface of the fruit is uneven.

Weight of fruit: 50 gr.

Colouring: greenish yellow, the skin is covered with a thick hoary coating; there appears to be no stem whatever and the fruit is joined to the branches by means of a special protuberance in the middle of its upper part.

Calyx: half open with large sepals, in the middle of which a bunch of pistils is preserved; it is placed in a deep, ribbed basin.

Core: broad conical shape with five closed seed carpels—containing from four to eight seeds placed in two long rows along the axis of the fruit.

Flesh: compact, sweet to the taste and strong, pleasant aroma, very good when cooked with sugar.

The fruit keeps until January; the tree is resistant to frost; not tall—two to three metres in height; tree keeps well in dry location.

The blossoms are large and pale pink in colour, are placed on the one-year-old new shoots of the preceding year, blooming time later than all the apples and pears. Crop cannot be said to be abundant, but tree bears nearly every year.

Severnaya quince is an excellent frost-resistant stock for pears; it enables the cultivation of pears to be extended far to the north; moreover, its fruit can be used for technical processing.

1932

SERVICE TREE

(*AMELANCHIER VULGARIS MOENCH.*)

During the past few years I have been testing the service tree as stock for dwarf types of pears and apples, and I have found that it is a good dwarfing stock capable of serving as a substitute in this respect for quince in the case of pears, and for the Paradise in the case of apples.

The graft on the service tree takes on firmly, and the pear and apple grafted on to it are more low-growing than those grafted on other dwarf stock such as quince and Paradise. Special attention should be paid to the service tree, and it should be tested in different parts of our Union as a stock. Because of its hardiness and the ease with which buds become grafted, it can bring about a great change in fruit growing in those places where the cultivation of dwarf fruit plants is a necessity, particularly as regards the northern localities of our Union where the climate is severe—Siberia and the Urals.

MOUNTAIN ASH

LIKYORNAYA

Fruit breeders, both here in our Union and abroad, have paid absolutely no attention to the improvement of mountain-ash varieties.

The mountain ash has not been used as a fruit tree by hybridizers for whole millenniums, and therefore it does not figure at all among the assortments in our orchards as a valuable fruiter.

It can be found in the central and northern zones of our Union growing wild only in the woods and on the outskirts of our orchards, and its fruit is almost inedible for man; only the thrushes can peck at them, and then only in the late autumn, after the first morning frosts.

True, the fruit of the bitter mountain ash may be used sometimes, but, I repeat, only after it has been touched by two or three snaps of autumn frost, and it is eaten mostly by children rather than by adults.

With the object of raising new varieties of sweet mountain ash for the central and northern zones of the R.S.F.S.R. and of extending the breeding of new, more cultivated varieties far to the north and to Siberia, in 1905 I crossed our bitter mountain ash (*Sorbus aucuparia L.*) with the mountain ash *Sorbus melanocarpa Neynh.*, which I procured from Germany and which bears sweetish, edible fruit.

The hybrid I obtained, named Likyornaya, is fully resistant to our severe winter frosts.

The fruit of the new variety of mountain ash is quite black, sweet, and serves to make good preserves, cordials and excellent liqueurs.

1932

BURKA

Among other interspecific hybrids of the mountain ash that are distinguished for their hardiness, sweetness and size of fruit, mention should be made, in addition to the Likyornaya, of the mountain ash Burka, which was obtained in 1918 from a cross between the Alpine mountain ash (*S. alpina*) and our bitter mountain ash (*S. aucuparia L.*).

The fruit of the Burka is about twice as large as that of our ordinary bitter mountain ash; it is of a reddish brown colour and sweet to the taste. The tree is extraordinarily resistant to our frosts.

1932

GRANATNAYA

Here I describe an extremely interesting intergeneric hybrid, which I have named Granatnaya, obtained from the fertilization, in the spring of 1925, of the blossom of our common bitter mountain ash (*Sorbus aucuparia L.*) with the pollen of the Siberian hawthorn (*Crataegus sanguinea Pall.*).

The seeds sprouted in the spring of 1926. The first bearing occurred in 1930, in the fifth year of its growth.

The tree of this hybrid is of medium height and has unpaired leaflets on the leaves; it produces fruit the size of a cherry, of ribbed shape, sweet-sour taste without bitterness, is useful for the confectionery trade. It produces an abundant crop and is fully resistant to our severe frosts.

The branches bear very beautiful and striking clusters of fruit the colour of pomegranate, that is why I named this mountain ash Granatnaya.

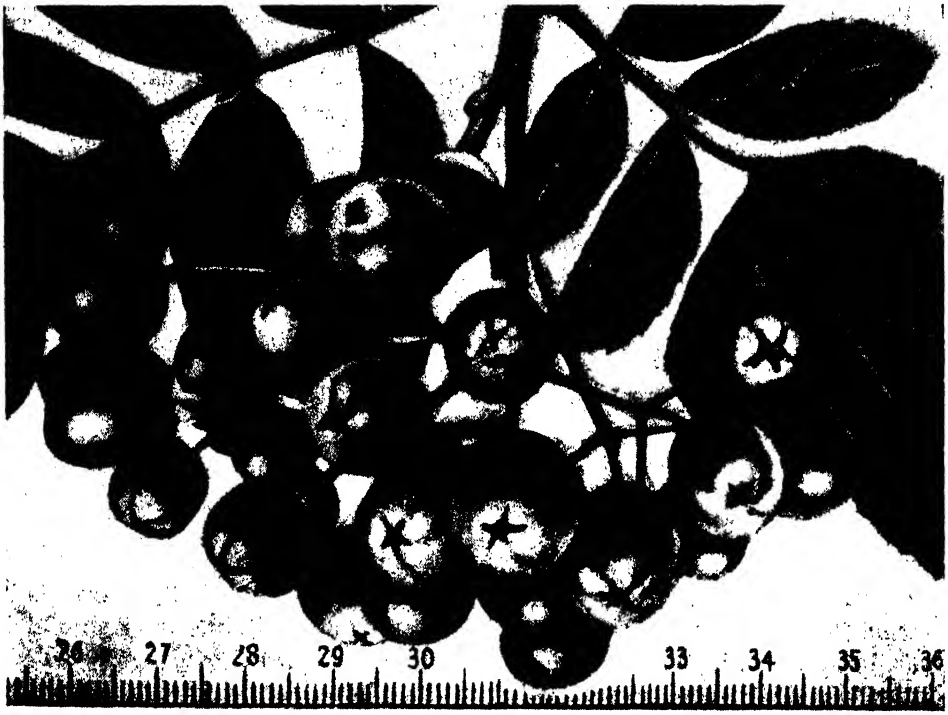


Fig. 140. Hybrid mountain ash Granatnaya

This variety of mountain ash deserves to be widely cultivated in the sovkhozes and kolkhozes in the northern zones of the R.S.F.S.R. and Siberia, as the fruit can be very successfully used for technical processing.

1932

MICHURIN DESSERTNAYA

As regards flavour, this variety of mountain ash is so far the best I ever raised; not only are all the sweet varieties of mountain ash that I have previously raised unable to compete with it for flavour, but I have so far not met a single South European variety of this plant that can in the least degree compete in flavour with this new, masterpiece mountain ash that I have raised during the past few years of my work.

I obtained the mountain ash Michurin Dessertnaya from a crossing that I made in 1926 between the Likyornaya mountain ash and a medlar (*Mespilus germanica L.*). The seeds sprouted in 1927 and the first bearing occurred in 1931.

The fruit of the hybrid is of medium size, red in colour, very much resembles a medlar in shape, calyx has wide-open, radially disposed interstices corresponding to the number of carpels, i.e., five.

Fruit are of a sweet flavour with a very slight touch of the bitterness of the ashberry, which gives it a peculiar, subtle, piquant flavour.

The tree is low, at five years of age it reaches 1.5 m. in height and is undoubtedly hardy in our parts. Thanks to its dwarf growth, the mountain ash Michurin Dessertnaya can spread far to the north where they dare not even dream of any other kind of cultivated fruit tree; a single snow covering for the shoots of the mountain ash Michurin Dessertnaya is sufficient to enable the trees to produce an abundant crop of fruit every year, which can be used not only for technical processing but also as an excellent dessert in the North European part of our Union and in the severe climatic conditions of Siberia.

This variety deserves to be most widely cultivated in the agriculture of these northern localities, and even in the central part of the R.S.F.S.R. it will play an exceptionally big role not only as a variety, the fruit of which can be eaten fresh, but also as the parent for producing cultivated varieties of mountain ash with fruit of finer flavour and larger size.

1932

CHERNOPLODNAYA

(SORBUS MELANOCARPA NEYNH.)

Of the old varieties of mountain ash in the central and northern zones of the Union none bear fruit that is more or less sweet, and if there are any, such as the Moravskaya, they perish in the very first severe winter, or else are damaged by late frost in the spring and suffer very much from this.

The Chernoplodnaya mountain ash is a valuable fruit tree in our region, as it is fully resistant to our severe winter frosts and produces black fruit of fine sweet flavour which can be successfully used for technical processing.

Distinguished for its dwarfish height, not exceeding one metre, the Chernoplodnaya mountain ash can also grow successfully in districts more to the north of the former Central Black-Earth Region, because it is sufficient to cover its branches with snow for the shoots, protected in this way, to produce fairly large, beautiful fruit of a bright, black colour.

Lately, considerable attention is beginning to be paid in the Union to the planting in the fields of shelter belts for the purpose of snow retention, and hence, moisture, for combating drought.

At first it was intended to plant in these belts trees such as maple, elm, poplar and others, but lately it has been decided to plant fruit trees for this purpose so as, in addition to retaining the snow in the fields, to obtain crops of fruit that could be used not only for technical processing, but also as dessert in the consuming, big industrial centres.

For this purpose, as will be shown later, I have raised by hybridization and selection the cherry Polyovka and have introduced some improved varieties of fruit plants, among which the *Prunus tomentosa Thbg.* and the Chernoplodnaya mountain ash described here will be of primary importance among other species of fruit and berry plants.

The Chernoplodnaya mountain-ash type has a low bushy crown with closely-spaced branches, so that when planted at short intervals the trees form a hedge which efficiently and quickly collects at near and far distances the snow that compensates for the inadequate summer moisture and increases the yield of field grain crops and of other useful agricultural plants.

Fig. 141. Chernoplodnaya mountain ash (*Sorbus melanocarpa Neynhold*)

The fruit of the Chernoplodnaya mountain ash can be used for making preserves, jam, etc., and also for dessert in those localities where the climate is severe and there is a shortage of other fruit.

This mountain ash will also acquire great importance in our hybridization work to raise new varieties of this plant with sweeter and larger fruit.

1932

SOUR CHERRIES

ANDO

Ando is Chinese tomentose cherry (*Prunus tomentosa Thbg.*). With this variety an entirely new species of stone fruit hitherto unseen in European

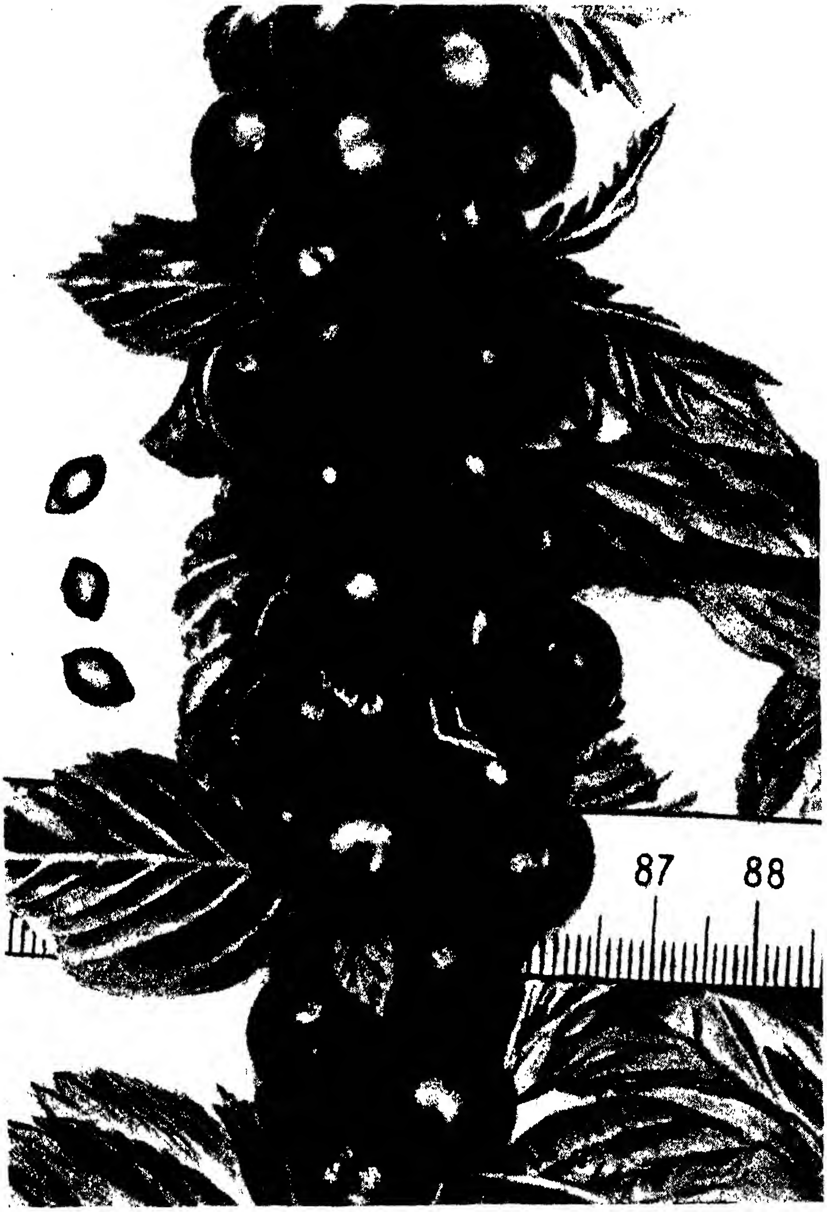


Fig. 142. Yield of Ando cherry

orchards is being introduced for cultivation in the orchards of the former Central Black-Earth Region. Its home, in all probability, is China, where it is known as Ando, although according to certain historical data varieties of this species have been met with before in different places on the South European coast of the Mediterranean.

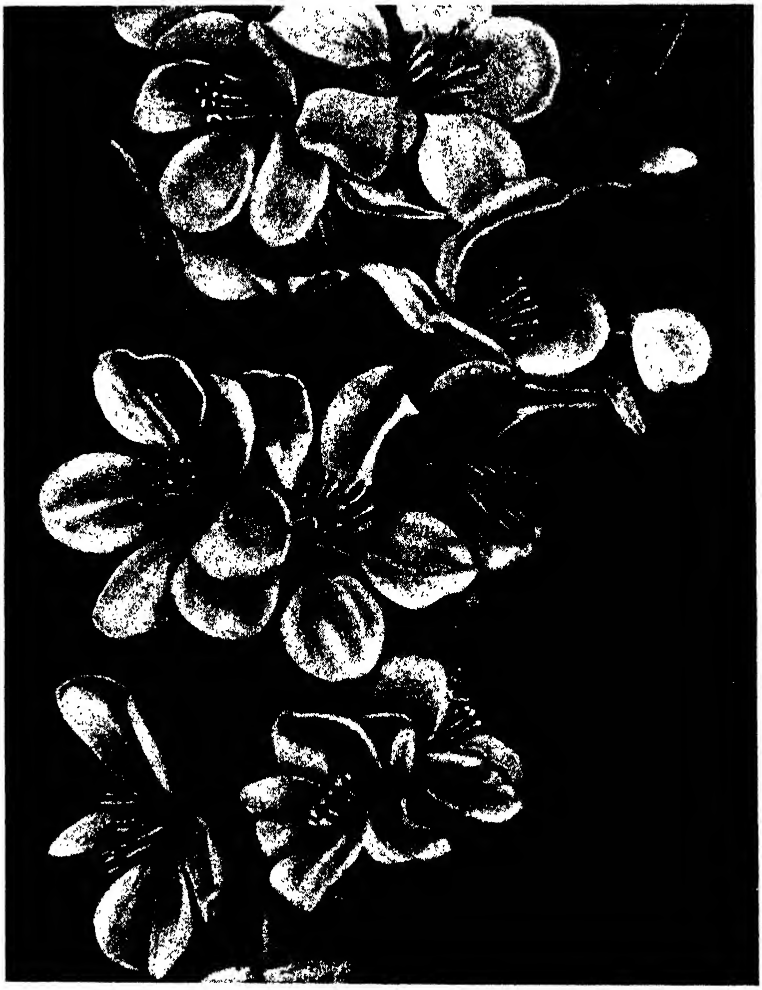


Fig. 143. Branch of Ando cherry blossoms

Evidently, however, these wild varieties bore fruit of an unenviable quality and for that reason were not used for cultivation in orchards.

From the seeds I planted in 1923 I obtained over a hundred seedlings. In the course of the next five years there were singled out by selection for hardiness, productivity and size of fruit, several specimens, from the seeds of which I am now propagating this species of cherry.

This peculiar bushy plant, no higher than 1.5 m., has nothing in common with our cherries either in the shape of its shoots or in its velvety leaves.

It bears an astonishingly large crop; the branches are weighted down to the ground by the fruit.

Shape of fruit: round, slightly turnip shape.

Colouring: bright, light red.

Size: length 18 mm., diameter 18 mm., weight 3.5 gr.

Stem: very short, so that the fruit sits close to the branches.

Flesh: very juicy, pink in colour, flavour quite sweet.

Stone: very small, smooth surface, pointed.

Ripening time: middle of July.

Properties of tree: resistance to winter frosts complete; only late spring morning frosts often harm the generally early development of spring shoots and blossoming.

Nevertheless, the extremely big crops and the luscious sweet fruit, which is suitable for confectionery and for cherry wine, should attract the attention of fruit growers in the former Central Black-Earth Region to this new species, fit for extensive cultivation in socialist field orchards by planting the stones and selecting the hardy specimens.

This variety is also needed particularly for crossing with European varieties of plums and cherries.

If it is found necessary to propagate this cherry by budding, then the only stock that can be used for the Ando are the cherry plum and the damson, but not cherry.

1932

THE BASTARD CHERRY

This new variety of sweet-sour cherry was obtained from a cross between the Rogneda cherry and the black wild cherry. This variety is therefore an interspecific hybrid of *Prunus Cerasus L.* and *Prunus avium L.*

Of outstanding interest in this cherry is the structure of its shoots and its vegetative development.

The shoots stop growing in the latter part of July, and they grow in height very slowly. After the shoots stop growing in height they begin to thicken considerably. Towards the end of their vegetation the shoots are extremely thick and have very close internodes, so that looking down on the leaves they appear to be arranged in a close rosette. The peculiar structure of the crown, shoots and leaves sharply distinguish the outward appearance of this variety from other varieties of cherries.

The application, in the spring of 1931, of fertilizer consisting of lime and clay, followed by a thin layer of well-decayed manure around the stem, extended the growing time of the shoots to August 10 and the new growth

was almost double that of previous years. When growth stopped, the shoots began to thicken very quickly.

The ripening of the fruit of this variety was also an interesting phenomenon. After blossoming, the setting fruit began to grow to such an extent that they at once exceeded all the other varieties of cherries that are outstanding for their size, but on reaching approximately the size of a bean which they did in a very short time, the fruit of the Bastard cherry suddenly stopped growing and for nearly six weeks remained quite green and showed

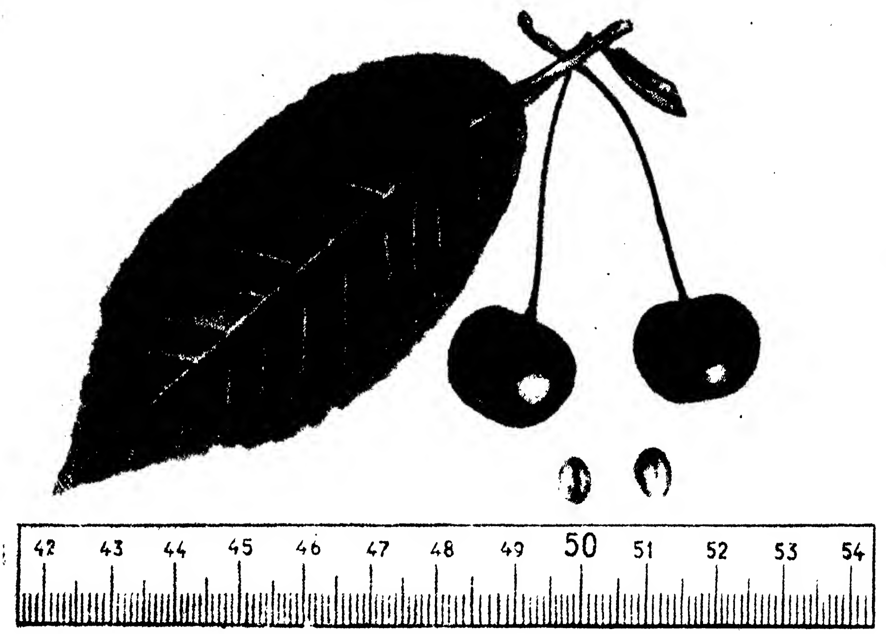


Fig. 144. Bastard cherry

no increase in size. In the latter part of July the fruit gradually began to grow and acquire colour, and by August 15 was already fit to eat.

Shape of fruit: blunt heart-shaped, greatly compressed where the stem is attached to the fruit and also at the base of the pistil.

The outline of the fruit is irregular, the suture indistinct. The base of the style is rather conspicuous and lies in a deep, slightly ribbed cavity; in some fruits there are slight depressions in the upper part of the cavity on both sides of the flattening. In general, the entire shape of the fruit entirely resembles that of the sweet cherry.

Colouring: deep red, almost black, subdued-lustre colour spread evenly over the whole fruit; skin compact but not elastic, breaks easily, adherent.

Size: length 14 mm., diameter 18 mm., weight 2.5 gr.

Stem: reaches a length of 39 mm., medium thickness, bright-green colour, small brownish spots observed on the sunny side. The stem is lodged in a deep, broad, rather regular cavity; attachment to the fruit tenacious.

Stone: medium size, full, oval shape, flesh coloured with pale-pink tint; neither ridge, blunt nor sharp, conspicuous; from the sharp ridge small, sharp furrows run to the side. The blunt ridge is conspicuous only on the upper part of the stone where it protrudes in the shape of a fairly large beak.

The stone is free.

Flesh: compact, fibrous, dirty-dark red, juice deep red, somewhat muddy, sweet-sour in taste.

Ripening time: first half of July.

Properties of tree: at the age of five the seedling reaches the height of two metres. The crown is very compact, the shoots are very thick with closely-set internodes; the leaves are long, narrow oval in shape, somewhat narrower at the petiole than at the apex; the petioles are fairly long and thick, a deep groove runs from the upper part of the petiole down the whole length, the glandules on the petiole are large and yellowish brown in colour; in general, the structure of the leaf rather closely resembles that of the leaves of the sweet cherry. The tree is completely resistant to our severe frost; does not suffer from any diseases.

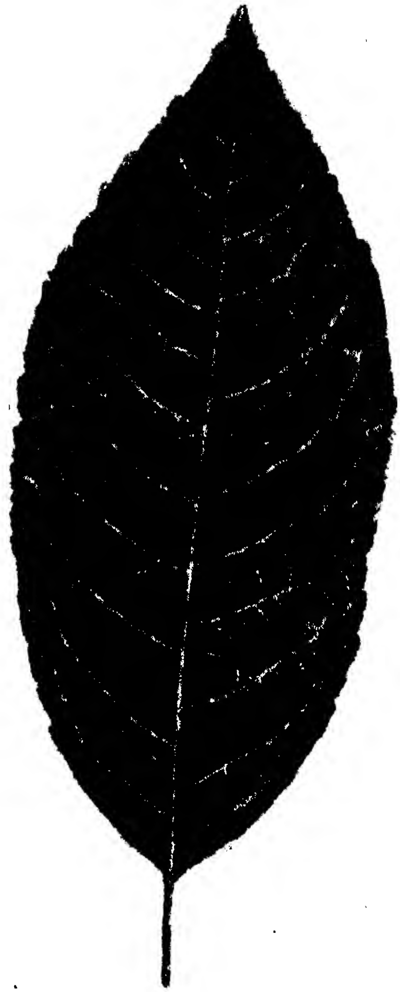


Fig. 145. Leaf of Bastard cherry

This variety will be of great importance for hybridizing work in raising new interspecific frost-hardy varieties of sweet-sour cherries.

1932

Fig. 146. Yield of Bastard cherry

THE IDEAL

The origin of the plant structure characteristic of this variety of myrtle-leafed cherry is extremely interesting. It was produced in 1906 from the common, Samara, wild steppe cherry (*Prunus Chamaecerasus Jacq.*), a blossom of which was fertilized with the pollen of a Pennsylvanian cherry from America (the so-called *Prunus pennsylvanica L.*). The latter is a tall tree which produces small, pink fruit, the size of a pea. In the hybrid this was reflected in the exceptional smallness of the leaf blades, which in shape and size resemble the myrtle leaf. The shoots of the new Ideal variety are extremely thin; as a consequence, they are almost useless for taking buds for the purpose of propagation by budding, which, happily, can be dispensed with, as this variety rapidly and independently propagates itself by root-shoots. All of the latter, already in the second year of their emergence from the ground, begin to bear abundant fruit of medium size.

Shape of fruit: turnip round, regular, the base of the style is placed in a barely perceptible depression.

Colouring: uniform, pale pink, skin bright, thin, smooth, elastic, free.

Size: length from 12 to 15 mm., diameter from 15 to 17 mm., weight 2.5 gr.

Stem: thin, up to 50 mm. long, slightly curved, firmly attached to fruit spur, pale green, patches of a dirty yellow scattered along the length.

Attachment to the fruit tenacious, so that no windfalls are observed.

Stone: extremely small, elongated oval shape, very compact; sharp ridge not prominent, blunt ridge also not prominent.

In the seedling there is no "segregation of parent types" as a result of self-pollination.

Flesh: pale pink, light coloured juice, consistency of flesh of medium firmness, sweet, slightly sour, makes preserves of excellent flavour and especially aromatic.

Ripening time: early, first part of July.

Properties of tree: low, not more than two metres high, undoubtedly fully resistant to winter frosts. In addition to these merits, this variety possesses the outstanding ability of easily crossing not only with other varieties of sour and sweet cherries, but also with various species of bird cherry. Among its hybrids are found quite a number of valuable new types of *Prunus* which I have named "Cerapadus" (*Cerapadus Michurin*).

This variety is truly ideal for kolkhozes because it does not need much tending. It is sufficient to plant a few layers of this annually bearing variety in any spot and within five years its abundantly-bearing offshoots will overrun a whole plot.

The layers, once planted, need no further soil loosening nor fertilizer, and this, in big kolkhozes, will save time needed for other agricultural work; all they need is protection from damage by cattle, and the clipping of dried branches from time to time. This is a first-grade variety.

1932

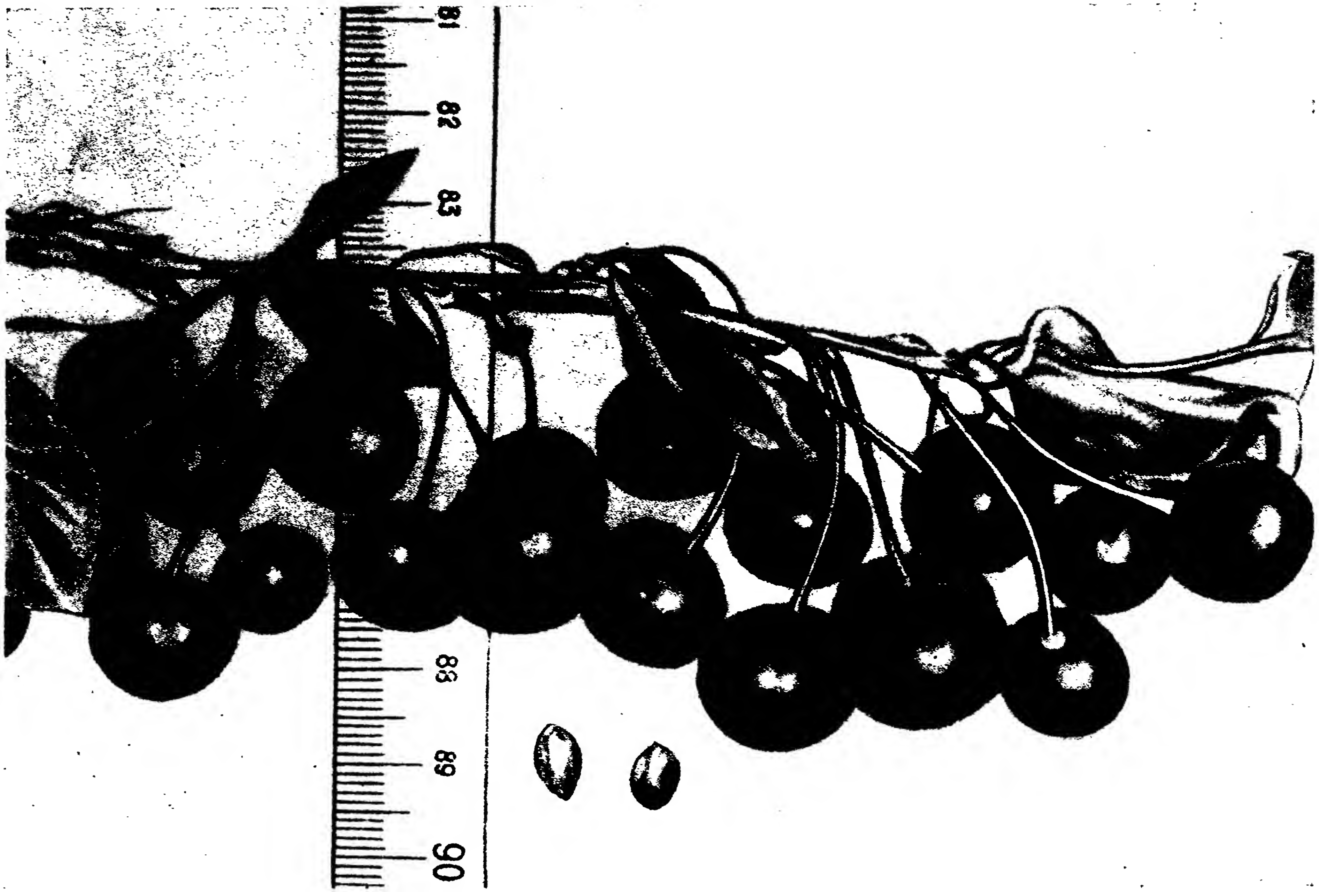


Fig. 147. Ideal cherry

KRASA SEVERA

This hybrid variety originated (in 1885) from a stone of the Vladimirskaya Rannaya sour cherry known in the city of Vladimir as Beli, the blossoms of which were fertilized in 1884 with the pollen of a Winkler White Cherry.

The crossing was accompanied by careful castration and all measures of precaution were taken at the fertilization.

Thus, this new variety is a hybrid of the common sour cherry and sweet cherry, which is evident from its habit and many other characters. The first bearing occurred in 1888, in the fourth year of the seedling's growth.

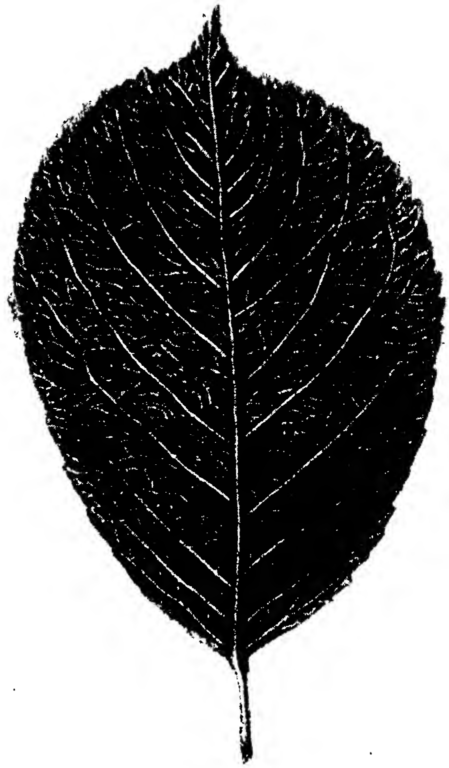


Fig. 148. Leaf of Krasa Severa cherry

The fruit of the first three years of bearing was of outstanding size, up to 30 mm. in diameter, and perfectly white, as a consequence of which I named the new variety Belaya Morello, but on propagating it by budding on a stock of seedlings of the common red sour cherry (probably due to the influence of the stock) the grafted trees began to bear fruit of pink colour with yellowish sides, and later the entire fruit became an even pink.

It is evident from this experiment that the new white variety of sour cherry should not have been subjected to the influence of stock from the seedlings of the red sour cherry. The change in the colour of the fruit compelled me to change the unsuitable name for a new one.

In view of the specific colour of the new variety's fruit and its remarkable resistance to frost I decided that the most suitable name to give it was Krasa Severa (Beauty of the North). This variety of cherry requires good black soil, on which it produces abundant crops, as is evident from the opinions expressed about it by the fruit grower Reshetnikov, of Kuibyshev (published in the magazine *Sadovod*, No. 9, 1906, and in *Vestnik Sadovodstva, Plodovodstva i Ogorodnichestva*, No. 1, 1908), where he writes: "Incidentally, there is a photograph of a two-year-old Krasa Severa tree, in my nursery, literally covered with fruit, and also a photograph of the fruit, natural size, of this truly admirable

variety which, in my opinion, has a splendid future, because, with its enormous and wonderfully delicious fruit, Krasa Severa can boldly compete not only with all the northern varieties but also with many southern ones."

It is also evident from these opinions that, in Kuibyshev, this variety, which is splendid in all respects, has proved to be highly productive and resistant to the 30° frosts that occur there. On sandy, dry soils, however, its crop is small.

Shape of fruit: turnip-shaped, fairly regular, the base of the style lies in a small depression.

Colouring: pale pink; skin smooth, bright, elastic.

Size: length 25 mm., diameter 30 mm., weight 8 gr.[1]

Stem: fairly thick, length 45 mm., lies in a round cavity of medium depth; stem firmly attached to stone.

Stone: round, medium size, light colour, evenly rounded at the narrow ridge; ridges very prominent, narrow one sharp, broad one blunt; half the number of stones contain undeveloped kernels, incapable of sprouting. The latter character is due to the crossing of parents remote from each other, which is often observed in hybridization. The habit of seedlings from well-developed kernels, however, reveals no sign whatever of "segregation"; the characters are mixed in different combinations. The stone is free.

Flesh: very juicy, bright, colourless juice, veins show a touch of yellow, the flesh is sweet with a slightly sour, refreshing, pleasant flavour.

Ripening time: the ripening of the fruits is fairly simultaneous and very early, in the first part of July; overripe fruit hold fast on the tree and are less subjected to the ravages of birds than those of all other varieties.

Properties of tree: reaches 2.5-3 m. in height, gummosis on stem and branches a very rare phenomenon, and in general the tree has a perfectly healthy appearance, which is one of the outstanding merits of this variety. Undoubtedly hardy, not only does the wood suffer no harm from winter frost, but the blossoms too will stand spring morning frost, as a consequence of which the variety bears a good crop every year.

The tree is luxuriantly developed. The leaf blades are of a dull, dark-green colour, very large, reaching a length of 140 mm. and a breadth of 90 mm.

[1] From the works of Prof. I. N. Konovalov, *Fruit Bearing of Certain Varieties of Sour Cherries* (1927, Voronezh), it is evident that of the sixteen varieties of sour cherries that he investigated as regards average daily increase in weight of ten fruits of all varieties and all periods, the average for Krasa Severa in the third period, from June 21 to complete ripeness, was 1.21 gr. Of the other varieties the largest increase was shown by the sour cherry Montmorency—0.96 gr.

On p. 7 of the works mentioned, Prof. I. N. Konovalov informs us: "The largest and heaviest fruits were those of the variety Krasa Severa, produced by I. V. Michurin, characteristic of which is a well-developed flesh and relatively soft stone."

The leaves are obovate, well-rounded at the apex with a narrowly projecting nipplelike prolongation of the midrib, margin—crenate. Leaf stalks thick, relatively short, green with reddish tint, has two and sometimes three wart-like protuberances.

I am describing the shape of the leaf in order that the kolkhozes that would like to try this variety in their orchards may be able easily to distinguish it from others before bearing commences, the more so that such a shape of leaf is not met with in any other variety of sour cherry whatever.

According to information received from localities to the north and east of ours, this variety has met with general approval, particularly in the former Samara Province, where it created quite a stir among horticulturists. The frost-hardiness of the Krasa Severa is so pronounced that it has become very widespread in Siberia, in the former Tomsk Province, where it is being propagated in the nurseries of those parts.

The outstanding size and beauty of the fruit of this new variety can very well serve as the best ornament for an exhibition assortment. Because of the pale-pink syrup, it makes preserves of excellent flavour and appearance. The tree's good resistance to frost and disease gives one every right to class this variety as first grade. I earnestly urge sovkhozes and kolkhozes to pay special attention to this new hybrid which has already been fully tested for many years.

1932

MONOMAKH

I obtained this variety in 1892 from a cross between the Lotovaya sour cherry and the pear-shaped Griotte.

The stone was planted in the spring of 1893.

The first bearing occurred in the sixth year of growth, i.e., in 1898.

Shape of fruit: round, compressed at top and bottom, regular.

Colouring: uniform dark red, skin surface bright, smooth, rather thin, skin is free.

Size: length 18 mm., diameter 19 mm., weight 4 gr.

Stem: rather thick, slightly curved, or not curved at all, rather compact structure, firmly attached to fruit spur.

External appearance of stem: pale-green colour, some have flush of cherry spots on sunny side. The stem is firmly attached to the stone, as a consequence of which no windfalls are observed.

Stone: round, full, blunt ridge rather prominent.

Flesh: reddish-cherry colour; of medium firmness, colour light red; sweet flavour. The stone is free.

Ripening time: latter part of July.

Properties of tree: medium height, broad, spreading crown; undoubtedly hardy to winter frost in our localities; the tree is healthy, is not sub-

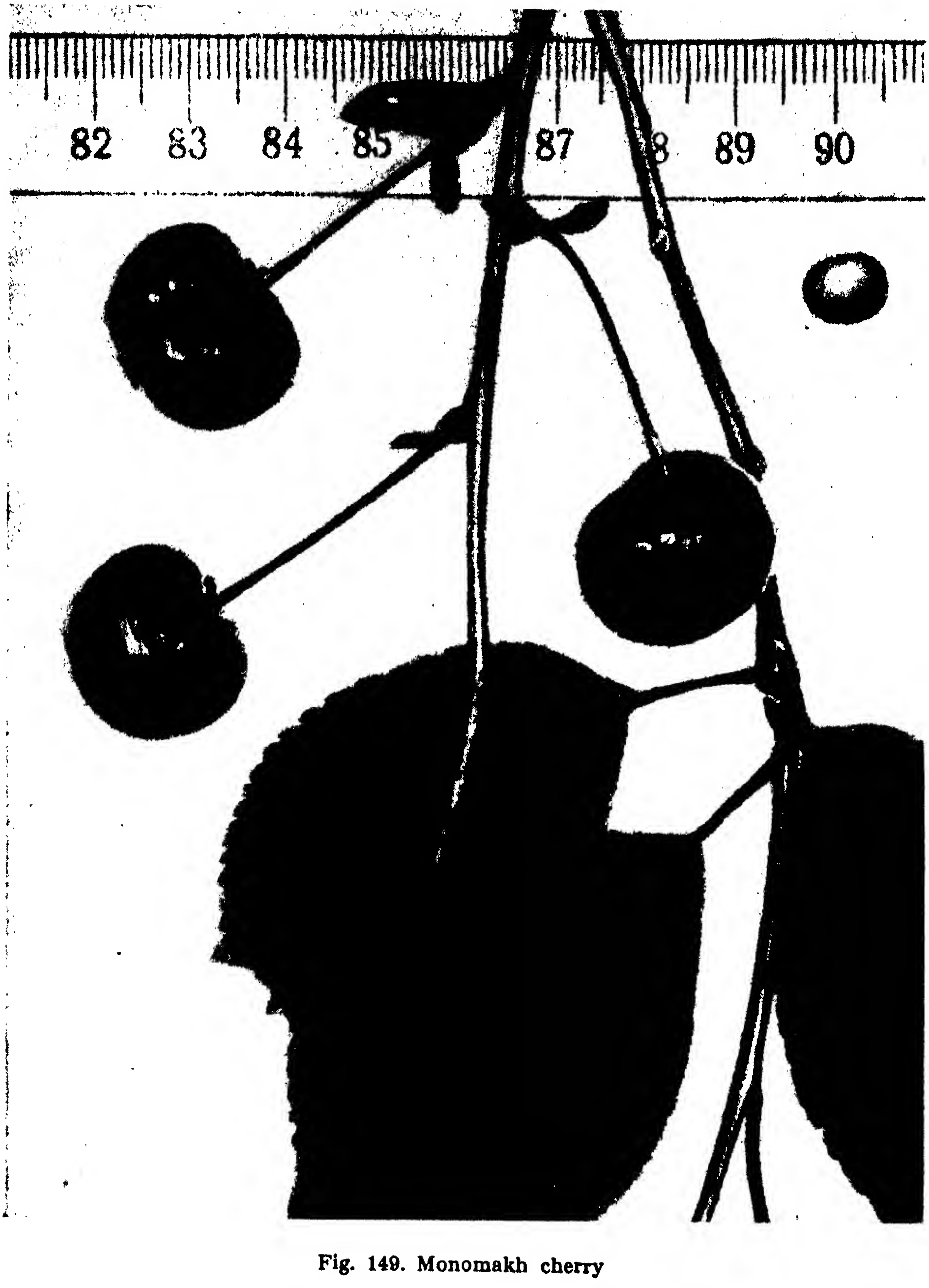


Fig. 149. Monomakh cherry

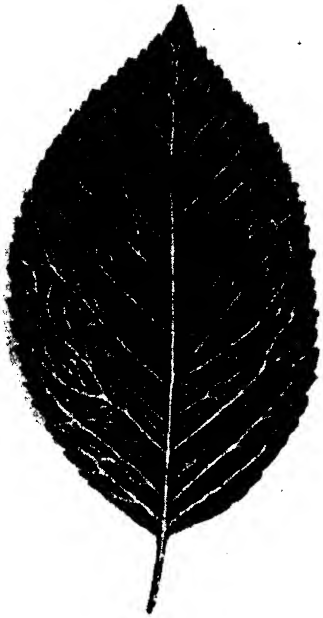


Fig. 150. Leaf of Monomakh

ject to the diseases of the animal and plant world, suffers little from gummosis.

A first-grade variety.

1932

MORELLO MINDALNAYA

In the March issue of *Vestnik*, 1907, I described a new variety of plum, which I had named Tyorn Sladky, and adduced proof that it is possible to obtain new varieties not exclusively by the sexual propagation of seeds, but also by the purely vegetative method (for example, by grafting); I also stated that the vegetative method of propagating plants cannot always keep the specific features of the propagated variety unchanged.

In the present article I describe another very interesting fact—the production of a new variety of sour cherry, which, I believe, is only the result of the particularly sharp and strong influence of the stock upon the very young graft of the seed variety. Although in the present case, as will be seen from the further description, there is a suspicion that the pollen of an *Amygdalus georgica* may have influenced the emergence of this variety, the possibility of cross pollination between species so remote from each other, in my opinion, is extremely doubtful. The more so that an absolutely analogous case of a

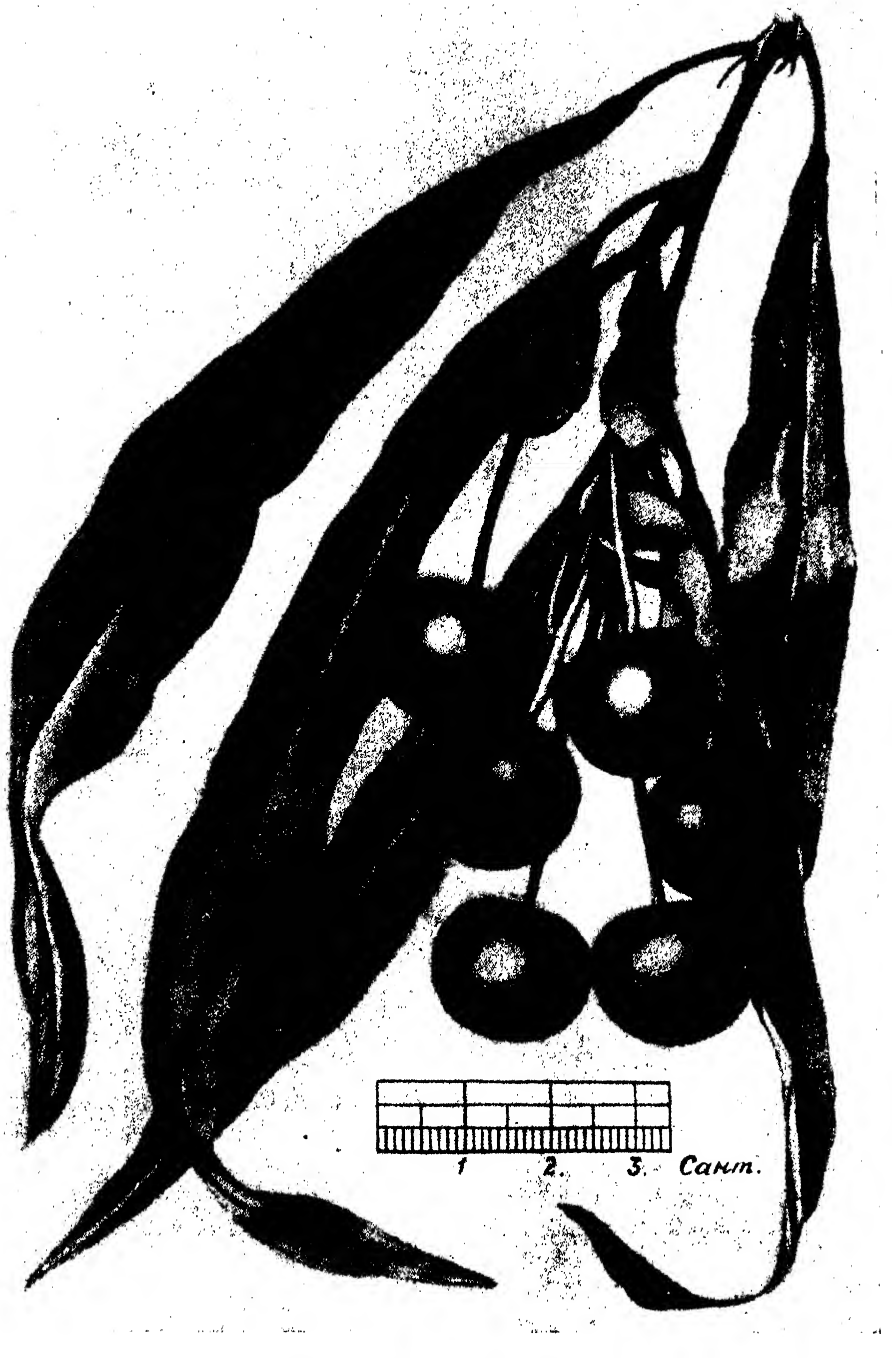


Fig. 151. Morello Mindalnaya

change in the shape of the leaf of a graft occurred in the nursery of Lev Platonovich Simirenko[1] after budding an old and well-known variety of sweet cherry, the only reason for which could be either the influence of the stock or a chance change in the bud.

Future experiments and observation will probably reveal the reason for such phenomena; for the time being I will try to relate the fact as it actually occurred.

In one of the beds in my nursery, next to a row of adult specimens of *Amygdalus georgica D. C.*, there was a selected seedling that had been grown from a stone of the Early Morello sour cherry. In 1900, at the first blossoming of this seedling, which happened to coincide in the spring of that year with the belated blooming of an *Amygdalus*,[2] the flowering branches of the seedling—more than half the crown—mingled with the branches of the *Amygdalus*; the result was that the blossoms of the two trees came into close contact with each other. Then, the sour-cherry tree gave an abundant setting of fruit, which later drew my attention by the fact that they did not ripen simultaneously. Thus, at the beginning of July some were fully ripe while others were quite green and ripened only more than three weeks later. When the stones of the latter were planted, only one kernel sprouted in the following year, but the seedling that resulted showed absolutely no other distinguishing features in the external appearance of its shoots and shape of leaves other than a weak and morbid development of all its parts in the first year of growth, after being transplanted to a common bed with other selected cherry seedlings. It was this circumstance that made me doubt the seedling's having originated from the cross between the sour cherry and *Amygdalus*.

Incidentally, it should be noted that, notwithstanding the big difference in the structure of its blossoms and their parts, *Amygdalus georgica D. C.*, quite easily produces hybrids with some varieties of *Prunus*. For example, I have many of its hybrids with *Prunus pumila L.* at various stages of combination between these two different species.

Suspecting that the morbid growth of the seedling was due to a casual defect in the structure of the young plant's root system, in the following spring, in 1902, I cut the seedling down and grafted the cutting with two well-developed buds on to the root neck of a strong, three-year-old wild sour cherry. And here occurred the very interesting phenomenon of a change in the shape of the leaf blades; the longer the leaves developed, the more they assumed an elongated, narrow shape, totally uncharacteristic of sour cherries. There grew an extremely original and very beautiful plant with narrow, hanging leaves almost five vershoks long.

In the spring of 1906 the tree was transplanted and in the autumn its shoots were covered with thick clusters of fruit buds.

[1] And also in the nursery of a peasant near the town of Kozlov.

[2] Which I have observed very rarely, as nearly all varieties of the almond usually bloom two weeks earlier than the sour cherry.

The first blossoming, which occurred in 1907, was extremely profuse, and the shape of the blossoms and the disposition of their parts showed a marked deviation from the norm of the sour cherry. The crop was very abundant, and the clusters of dark red fruit enhanced the peculiar beauty of the tree. I herewith enclose a somewhat enlarged photograph of one of the branches with fruit.

The fruit has a pleasant sour-sweet flavour, it is round in shape and has a slightly deepening suture along its axis.

The stone is oval in shape, of small size and has a rather prominent special feature, namely, a twisted suture. Ripening—medium early.

The new variety of sour cherry described, which, because of the resemblance of its leaves to *Amygdalus*, I have named Morello Mindalnaya, is, in my opinion, owing to the good quality of its abundant fruit and for the striking beauty of the tree itself, worthy of extensive cultivation. Moreover, it would be very interesting to know whether it is possible to obtain a further transformation in the structure of the plant by planting its stone, and, in particular, it would be desirable to obtain a variety with fruit of elongated shape.

May 5, 1908

MICHURIN PLODORODNAYA

This variety originated in 1890 from a Michurin dwarf sour cherry selected for its annual fertility and described with a coloured illustration in the January issue of the magazine *Vestnik Sadovodstva i Ogorodnichestva* (pp. 34-38) for 1889.

The Michurin Plodorodnaya cherry differs from the mother plant only by its slightly greater height (up to 2 m.); the rest of its valuable qualities remained unchanged.

Shape of fruit: round, outline perfectly even.

Colouring: dark red, uniform, surface of skin smooth and bright; skin compact and firm, does not tear easily, adheres rather firmly.

Size: length 25 mm., diameter 25 mm., weight 6 gr.

Stem: medium thickness, up to 40 mm. long, firmly attached to shoot; firmly attached to stone, hence, windfalls never occur even if there is considerable overripeness. The stem is lodged in a small, sloping cavity.

Stone: rather large, elongated oval shape, smooth, double suture on one side. Planted stones produce up to 80% of constant seedlings, which begin to bear in the fourth or fifth year. Germinating capacity and viability very considerable, often sprout even in the third year from the time of planting.

Flesh: juicy, pleasant sweet-sour flavour, juice pink in colour, flesh—soft.

Ripening time: the fruit ripens by August 25, but the crop can easily keep on the trees until the middle of September, which is of great importance since other varieties of cherries are absent at this late period.

Properties of tree: the outstanding hardiness of the tree and of the fruit buds in particular to winter frost, and the fact that it is self-fertilizing, ensures an annual crop of this unique commercial variety, which for its productivity is far superior to all other varieties of sour cherry in our region. The crop from one adult tree amounts to 35 kg. I regard this variety as being so far the only profitable one for its productivity, and at the same time one of the best parents for producing new varieties of sour cherry. Its vigorous pollen not only fully fertilizes the blossoms of its own variety, so that, in essence, it is a self-pollinating variety (the only fully self-fertilizer among all cultivated varieties of such cherries) and does not have to be pollinated by neighbouring varieties of sour cherries; but its pollen successfully influences all the other varieties of sour cherry that grow in the vicinity of the Michurin Plodorodnaya and in this way increases the number of setting fruit on the trees of these varieties. Being short, the tree is very convenient for fruit picking and for protecting the fruit from birds.

Fig. 152. Leaf of Michurin Plodorodnaya cherry

The crown is broad and spreading. The stems of adult trees reach 10 cm. in diameter; sometimes suffers from gummosis, but this occurs only on rich, damp soils. Leaves of medium size, elongated, with short, relatively thick petioles, each having several glandules. The upper side of the leaves is of a dull green colour, the underside, however, is greyish-green, has a slight down and not conspicuous veins; serration small and blunt.

The blossoms are of the ordinary shape of other varieties of sour cherry, but the Michurin Plodorodnaya begins to blossom ten to twelve days later than the other varieties.

The Michurin Plodorodnaya is also one of the best parents in the work of hybridization for producing new varieties of sour cherry.

Producing excellent seedlings of new sour cherry varieties when planted in the ordinary way in the second generation, it, when hybridized with superior varieties, combines in its offspring all the best qualities the parents possess.

Distinguished for its immense resistance to our severe frosts, which reach

Fig. 153. Yield of Michurin Plodorodnaya cherry

almost 40°C. below zero, the Michurin Plodorodnaya enjoys great popularity in the United States and Canada.

In 1898, the all-Canadian congress of farmers, which was held after a severe winter, placed on record that all the old varieties of sour cherry, of European as well as of American origin, perished in Canada, except the Michurin Plodorodnaya from the town of Kozlov (now Michurinsk) in Russia.

At the present time this cherry is grown on enormous areas in America and enjoys well-deserved fame there.

Under our planned socialist system of economy, the Michurin Plodorodnaya cherry will play a big positive role in the economy of our sovkhozes and kolkhozes if used for mass orchard planting.

For its big, annual crops, outstanding resistance to frost and high productivity, this variety should be regarded as a unique, standard, first-grade variety, deserving of the widest cultivation in sovkhozes and kolkhozes.

1932

POLYOVKA

This new variety of sour cherry was so named because its characters and qualities are better suited than those of any known variety of sour

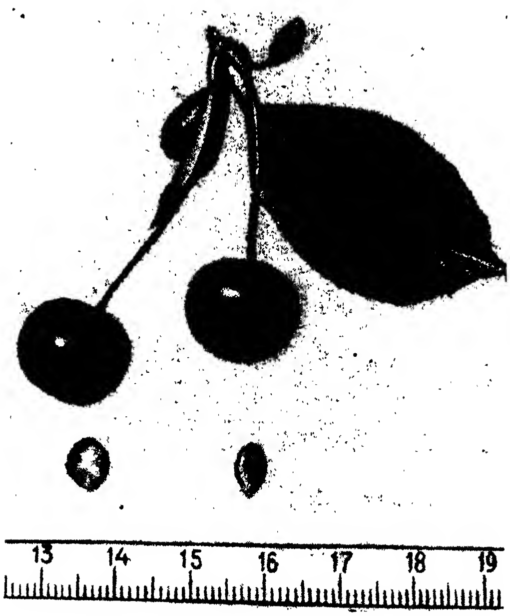


Fig. 154. Polyovka cherry

cherry for commercial cultivation in the open locations of shelter belts.

Being completely self-fertile, which, in general, is rarely met with among

Fig. 155. Yield of Polyovka cherry

cultivated varieties of the sour cherry, the blossoms of the Polyovka, fertilizing themselves with their own pollen, can completely dispense with cross-pollination with other varieties. Furthermore, the flower buds are, undoubtedly, fully resistant to the severest winter frosts that occur in our localities. Even late, spring morning frosts have no perceptibly harmful effect upon the blossoming and, as a consequence, abundant crops of this variety

repeat themselves year after year without the breaks that are usual for all other varieties of sour cherry, not excluding semicultivated, such as, for example, the Vladimirskaya (Roditeleva), and even *Prunus Chamaecerasus*.

In addition to all that has been said, the Polyovka is absolutely unexacting as to soil composition and to location and develops well both in dry and humid locations. Propagates easily from root shoots, and the stones, after planting, produce a considerable percentage of constant seedlings. This variety was obtained in 1925 from seedlings of the Ideal, from which it differs by its very tall growth, larger fruit and their dark colouring.

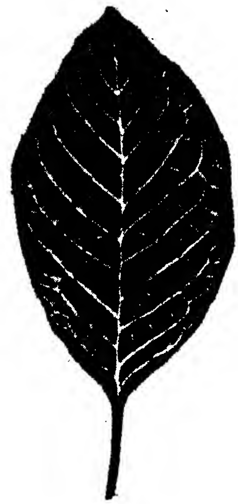


Fig. 156. Leaf of Polyovka cherry

Shape of fruit: round, even, has a shallow cavity at the place where it is attached to the stem.

Colouring: dark red, skin smooth, bright, of fairly compact texture.

Size: length 19 mm., diameter 20 mm., weight 3.5 gr.

Stem: thin, medium length, holds the fruit well until complete ripeness. Colour of stem greyish green.

Stone: small, elongated, prominent suture.

Flesh: juicy, dark red, medium compactness, sweet-sour flavour.

Ripening time: end of July.

Properties of tree: height of half stem 1.5 m., broad spreading crown; new shoots as well as fruit buds fully resistant to the winter frost of our localities. Nor do the blossoms suffer from spring morning frost; as a consequence there is an abundant crop every year. Not subject to the disease of gummosis.

I repeat, this new variety is beyond question the best for planting shelter belts in the open field.

1932

POLZHIR

This is one of the most remarkable hybrids the Ideal sour cherry could produce during the past few years of my hybridization work.

The Polzhir cherry belongs to the group of dwarf varieties of sour cherry that the Ideal cherry so often produces on being crossed with other first-grade varieties of sour cherry.

Produced from a cross between the Ideal and Plodorodnaya, this new variety took from these parents all the best of what they had: dwarf growth, frost-hardiness, large fruit and good crop.

Now that big, socialist orchards are being laid out, when "field orchards" of an area of several thousand hectares are no longer a rarity in our Union, when the vast work of construction going on in our country has already abolished unemployment once and for all and a great shortage of labour is observed in all branches of our economy, a big role in the laying out of these vast orchards will be played by a variety of cherry tree the fruit of which can be picked easily and quickly.

How much labour, time and funds will be saved by this!

The Polzhir can answer all the demands socialist fruit growing is making upon this new, excellent variety.

The sparse arrangement of the branches in the crown and the simultaneous ripening of the fruit make it possible to pick them in a short space of time on vast areas and to ship to the workers' districts of the big industrial cities standard, first-grade fruit which with no less success can also be exported abroad in a sulphatized condition.

The Polzhir is completely indifferent to soil, it can grow splendidly and bear fruit on rich and on thin, poor soils. The stern, Spartan regime of training to which I subjected this new variety from its earliest development, from the moment it emerged from the seed to its first bearing, enabled me to make this plant an armour-clad variety in every respect.

In the mass planting of cherry orchards in our sovkhozes and kolkhozes, the Polzhir should occupy a deserved place in the front rank, because, except for the Michurin Plodorodnaya, it has no rival in the central and northern zones of our Union.

The seed germinated in 1926; the first bearing occurred in 1930.

Shape of fruit: round, slightly compressed at the apex and flatter on the side of the stem; outline even, suture not as conspicuous as in other varieties of sour cherry, very slight flattening on the seam side. Remains of the style quite distinct, placed in a very shallow, wide depression of regular shape; in some of the fruits the depression is barely perceptible.

Colouring: red, with a dark-pink stripe on the suture; surface of fruit brightly varnished; skin thin, elastic, not easily torn, but free.

Size: length 23 mm., diameter 20 mm., weight 5 gr.

Stem: medium thickness, length 36 mm., pale-green colour with small, light-brown patches on the sunny side.

The stem is lodged in a deep, rather broad, regular shaped cavity; in some of the fruit the ridge slopes slightly towards the side seam; attachment to stone fairly firm.

Stone: round, small, smooth, pale straw colour, some stones are flesh coloured. On the side of the blunt ridge the stone is narrower than on the side of the sharp ridge; on the end where the stem is attached to fruit, both the sharp and the blunt ridges are very prominent, and on the upper part of the stone there are sharp protuberances which are more prominent towards the blunt ridge.

Flesh: orange colour, sweet-sour, compact, juicy. Juice a pale-pink colour, has a refreshing, pleasant flavour; stone free.

Ripening time: early, the fruits ripen simultaneously in the first part of July.

Properties of tree: height reaches 1.5 m., distinguished for its extreme frost-hardiness, which makes it possible to extend the cultivation of this, one of the best varieties of sour cherry, far to the north; not only does the wood suffer no harm from frost in severe winters when the temperature goes down to 40°C. below zero, but also the blossoms easily withstand spring morning frost.

As was stated above, the arrangement of the crown is sparse; the shoots are of medium thickness, flexible, with resilient wood capable of carrying the abundant annual crops. The leaves are of compact texture, dark green in colour, very bright as if greased, which explains why I have named this variety Polzhir.

Leaf margin finely crenate; petioles short, thick, pale green with brownish tint on sunny side; the leaves are of medium size, slightly broad elliptical shape.

Fig. 157. Leaf of Polzhir cherry

Neither fruit nor tree is subject to disease or attack by pests of the animal or plant world.

Gummosis on stem or branches has never been observed.

Produces root offshoot from which it is possible easily and quickly to propagate this splendid variety.

Thus, characteristic of this variety is the outstanding size and beauty of its fruit, from which can be made excellent preserves of delicious flavour and pleasing appearance owing to the transparent, pale-pink fruit.

The ability easily to withstand our frosts without either the fruit buds or wood suffering any harm, annual crops and dwarf size which enable it to bear fruit in regions where they dare not even dream of fruit growing yet owing to the severity of the climate, where a snow covering of the lower shoots will be enough in itself to enable this new variety to produce a quantity of fruit that will more than compensate all the expenditure involved in the cultivation of this, I repeat, outstanding variety—all this gives us the right to class Polzhir as a first-grade variety that deserves the widest and most rapid cultivation in our socialist economy—in sovkhozes and kolkhozes.

1932

ROGNEDA

I obtained this variety in 1901 from selected seedlings of the sour cherry Lotovka.

The first bearing occurred in 1905, in the fifth year of the seedling's growth.

Owing to its annual crop, the large size of its fruit and undoubtedly full hardiness, this new variety of sour cherry is a first-grade variety for the central and northern zones of the R.S.F.S.R.

Probably everybody knows that the chief defect of the small assortment of hardy sour cherry varieties extant in our local orchards is that nearly all of them produce crops not every year, but at intervals, and for some of these varieties the interval between one crop and another lasts from three to four years. This, evidently, is the main reason why the mass plantation of sour cherries for commercial purposes is not practised in our localities. As a consequence of this, our cooperative organizations have been obliged every year to hire cherry orchards in the South. It was only in the last two or three decades that I raised new varieties of sour cherries (among which is the Rogneda), which do not suffer from the above-mentioned defect and produce annual crops.

This important property of these varieties should attract the attention of the sovkhozes and kolkhozes that run cherry orchards for commercial purposes, for the main thing in running such orchards is that they should give an annual economic return.

Shape of fruit: cordate or irregular angular, outline even, base of style situated in a barely perceptible depression.

Colouring: dark red, uniform, skin smooth, bright, rather thin but firm, free of the flesh.

Size: length 20 mm., diameter 24 mm., weight 4 gr.

Stem: long, up to 50 mm., thin, colour pale green, in majority of cases without flush, which occurs only at the spot where the stem is attached to the fruit, placed in a fairly deep, broad, regular shaped cavity. Attachment to the stone tenacious, so that windfalls are never observed.

Stone: small, round, well developed, light colour; sharp ridge not conspicuous, the blunt one is very broad and prominent, which is very characteristic of this variety.

Flesh: juicy, pleasant sweet-sour flavour, dark-red colour, pulp fairly compact; colour of juice dark red; the stone is free.

Ripening time: end of August.

Properties of tree: medium height, thick shoots, leaf blades of medium size, fairly compact, leathery, colour dark green.

The whole plant is distinguished for its healthy appearance, does not suffer from gummosis; distinguished for complete frost-hardiness; abundant crop every year.

Fig. 158. Morello Rogneda

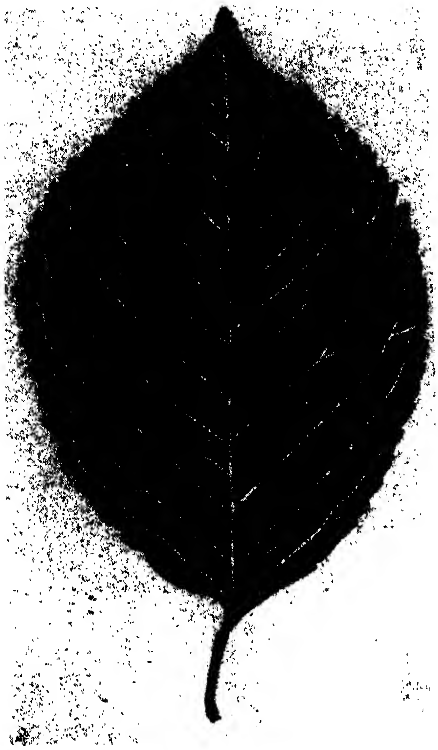


Fig. 159. Leaf of Rogneda

One cannot help noting the outstanding feature of this variety, namely, that it takes better than all other sour cherries when budded on seedlings of the common sour cherries. A valuable commercial variety.

1932

YUBILEINAYA

This variety originated from a sport deviation of a Griotte d'Ostheim bud that was grafted in 1914 on to a *Prunus Mahaleb L.* stock, which was distinguished from the other budded trees of the same variety by its fourfold more luxuriant growth, its hardiness, the exceptionally healthy appearance of the trees, powerful build and the large fruit they bore even on sandy, dry soils.

Shape of fruit: almost round, very slightly compressed at the top, even outline, suture indistinct.

Colouring: uniform, dark cherry; patches on the surface sparse and perceptible only on detailed examination. Skin smooth, bright, fairly firm, free.

Fig. 160. Yield of Yubileinaya cherry

Size: length 27 mm., diameter 28 mm., weight 6 gr.

Stem: 40 mm. long, medium thickness, lodged in a deep, regular, wide cavity; pale-green colour, on the sunny side often has a flush of small cherry-coloured patches; rather firmly attached to stone.

Stone: small, slightly rough surface, unequal; both ridges blunt, little distinguished against the general background.

Flesh: pinkish red with pale veins, juicy; consistency of medium compactness, flavour sweet and slightly sour, pleasant, refreshing; the stone is free of the flesh.

Ripening time: latter half of July.

Properties of tree: very vigorous, crown flattened spherical shape, compact; branches resilient, their wood strong; the tree is healthy, during the whole period it lived in the nursery the mother tree did not suffer from any disease caused either by animals or plants, gummosis was never observed; the tree is undoubtedly resistant to the frosts of the central zone of the U.S.S.R.; good productivity.

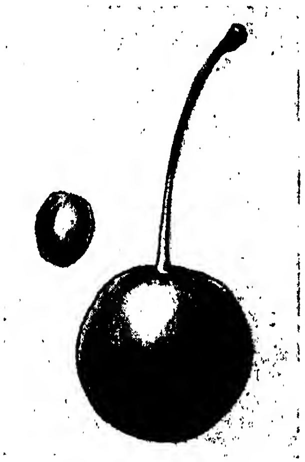


Fig. 161. Yubileinaya cherry (drawing by I. V. Michurin)

Fig. 162. Leaf of Yubileinaya cherry

For its undoubted merits—large fruit, healthy appearance of the tree, hardiness and good productivity—this variety must be classed as a first-grade commercial variety.

1932

CERAPADUS

EMERGENCE OF A TOTALLY NEW SPECIES OF *PRUNUS*, WHICH I HAVE NAMED CERAPADUS

During the past few years I have had occasion to observe an extremely interesting phenomenon—the appearance of a new type in the family of small drupes, obtained by crossing the cherry *Prunus Chamaecerasus* with the bird cherry *Prunus Padus Maackii*.

First of all it should be mentioned here that the hybrids one gets in crossing two different species, and also in crossing variations of one and the same species, are usually different each time as regards the combination of characters they have inherited from the parent plants. So infinite is the variety of combinations in hybrids of all heterozygous species of fruit plants that, in the vast majority of cases, it is impossible to fit them into any scheme of recurring regularity. This is so because the combination of properties hereditarily transmitted to a hybrid depends on the infinitely varied influences of external climatic factors, which allow the development of some characters in the hybrid and retard or altogether inhibit the development of others.

But here, for the first time in my fifty-six years' work, I had occasion to observe a thing which is altogether exceptional.[1] Here, although flowers of *Prunus Chamaecerasus* were, I stress, fertilized with pollen of *Prunus Padus Maackii* many times in different years, the resultant hybrids were always of a uniform type having nothing in common with the parent plants as regards any feature of outward appearance.

Further, F_2 and F_3 seedlings of these hybrids (i.e., the second and third generations) are likewise uniform, do not deviate in the least from the form of their species (just as homozygous pure species usually do not), and no segregation into parent types is to be observed.

The growth of most of these seedlings is bushlike and luxuriant.

Their resistance to frost is absolutely complete.

They fruit abundantly in clusters.

The fruits of all the seedlings unfortunately contain, not only in the stones, but in the flesh of the pericarps too, such a substantial amount of what I believe to be prussic acid as to be inedible by reason of their bitterness.

Looked at from a practical point of view, this species of *Prunus* can, owing to its luxuriant growth, powerful root system and ideal frost-hardiness, furnish a good stock for slow-growing frost-hardy cultivated varieties of sour cherries.

Date unknown

[1] And which indicates the way Nature has functioned in creating the whole host of plant species existing at the present time.

CERAPADUS No. 1

Cerapadus No. 1—an example of an interspecific hybrid—is an excellent parent type and a vigorous stock.

Of the experiments in the interspecific crossing of fruit plants, the breeding of this type presents special interest. This hybrid was raised in 1920

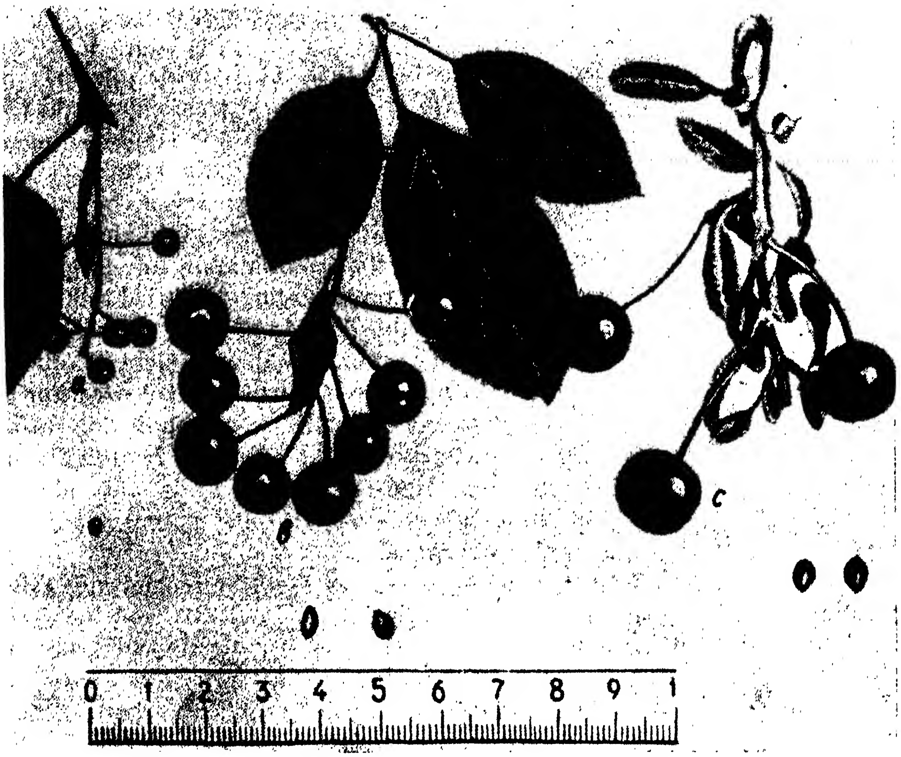


Fig. 163
a—Japanese bird cherry (male parent of Cerapaduses); *b*—Cerapadus No. 1; *c*—Ideal cherry (one of female parents of Cerapaduses)

from the stone of a sour-cherry seedling a flower of which had been fertilized in 1919 with pollen of the Japanese bird cherry (*Prunus Padus Maackii Rupr.*). In 1923, by way of improving its qualities, it was budded into a sweet-cherry stock, which was supplied to it as a mentor.

The seedling bore its first fruit in 1925, in its sixth year of growth.

This hybrid of remote species of *Prunus* (the Japanese bird cherry *Prunus Padus Maackii Rupr.* and the sour cherry *Prunus Chamaecerasus Jacq.*) grows to a stature more than double that of the maternal parent—the sour cherry.

Moreover, when eyes from one and the same shoot of this hybrid were budded into the five-year-old sweet-cherry stock which acted as mentor, three separate varieties of different constitution resulted.

These three grafts of Cerapadus buds on the sweet cherry put forth in the summer of 1924 strong shoots, two metres long and more, and three times as thick as those of the pure hybrid.

Though all three shoots were on the same stock, their growth in both length and thickness, and also the size and structure of their leaf blades, were totally different. The two shoots higher up on the stock were seven centimetres longer, but only half as thick as the third, lower shoot. The latter seems to have deviated in the direction of the sour-cherry mother plant, alike in its thick and stumpy growth, in the greater development of the leaf blades and petioles and in the greater breadth and short, roundish form of its buds compared with the long and narrow buds of the upper two, which deviated in the direction of the bird cherry, having long, slender shoots that did not form any fruit buds in this first year of growth. In this last respect too, the lower shoot was different: it formed a short spur with fruit buds of uniform structure, as some varieties of sour cherries are wont to do.

A similar bud sport variation was to be observed when a hybrid Beurré Easter seedling was bud-grafted onto the crown of an adult tree.

And so a hybrid can alter its constitution under the influence of outside factors. Now during the long (several years') developmental cycle of a perennial plant, a good many of these outside factors will operate, and consequently the deviations in the hybrid seedling's constitution may also be numerous.

It is otherwise in annual organisms of the vegetable kingdom and even in organisms of the animal kingdom whose constitution takes shape over a period of many years. The former have only a very brief developmental cycle during which outside, external factors can exercise their influence; and the latter, while their constitution does develop over a period of many years, exist in conditions which guard them against change.

In sum, whatever the adherents of the Mendelian law may say, all is not well with their fundamental tenets; there are some things there that must of necessity be revised.

Passing now to a description of the characters inherited by this interspecific hybrid from its parents, let me point out the difference obtaining in the autumn cessation of sap movement and the form of leaf fall.

In all sour-cherry varieties, the leaves remain in the same position and of the same colour throughout the vegetation period, and fall in the autumn without first losing their greenness.

In the case of the Japanese bird cherry (*Prunus Padus Maackii*) the process takes a totally different form. When the sap movement ends, all the leaves droop suddenly, within one day, from a horizontal to a pendent position, they seem to wilt; then, by degrees, they lose their green colour, the whole blade turning a pale yellow; and only then do they gradually begin to fall.

In the hybrid, we observe no such marked drooping, it is partial and inconspicuous. The leaf blades turn yellow only along the margin, and only on

Fig. 164. Blossoming of Cerapadus No. 1

the first two long grafted shoots, which have deviated in the direction of the bird cherry; while on the lower, shorter and thicker grafted shoot, which has deviated more towards the sour cherry, the leaves stay green until they fall. The leaf margin, instead of sharply serrate, is more crenate.

Furthermore, on the leaf petioles of the third, lower shoot, three or four well-developed wartlike glands have made their appearance, as in the case of the sweet cherry.

This and similar hybrids of bird cherry and sour cherry, which I have named Cerapadus, will in future, upon selection, probably yield completely new, independent types suitable for commercial growing.

Shape of fruit: oblate, contour even.

Colouring: at full maturity a uniform dark red; the skin is smooth and shiny, rather thin but elastic and hard to tear, adheres to the flesh.

Size: length 9 mm., diameter 10 mm., weight 1 gr.

Stem: 22 mm. long, of medium thickness, slightly curved, and sometimes not at all; it is firmly attached to the peduncle and sits in a fairly deep, wide and regular cavity.

Stone: small, full, of pale colour and elliptical shape, slightly sharper at upper end; attachment to stem tenacious, so that there is no windfall.

Flesh: succulent, cherry red in colour and fairly soft; its taste is subacid and definitely bitter; the stone is free.

Fig. 165. Leaf of Cerapadus No. 1

Ripening time: first half of August.

Properties of tree: habit of growth is low, the crown compact and densely foliated; the trunk is deep brown and flecked all over with small dots of dirty whitish brown; the bark scales a good deal.

The tree is perfectly hardy against winter frosts, does not suffer from diseases or gumming, and in general presents a completely fresh and healthy appearance.

The fruits come in clusters, as on the bird cherry, with four or five on a peduncle.

This new interspecific hybrid has a big future as a parent type for breeding improved high-yield sour-cherry varieties, with fruits coming in clusters, not in singles or pairs as they do in cherries generally.

This new type cannot be grown in orchards as a fruit plant because of its bitter taste; but as a strong stock with a very powerfully developed root system, it can be of considerable value for budding cherries, since it will supply abundant nourishment to the variety grafted upon it.

1932

SWEET CERAPADUS

This is one of the best and most interesting hybrids obtained by crossing two distant species—the Ideal sour cherry and the Japanese bird cherry (*Prunus Padus Maackii Rupr.*).

While the outward appearance of this hybrid is of the usual Cerapadus type, its fruits have a higher sugar content than the others, and this will be very valuable in hybridization for breeding new productive, large-fruited, sweet varieties of sour cherries.

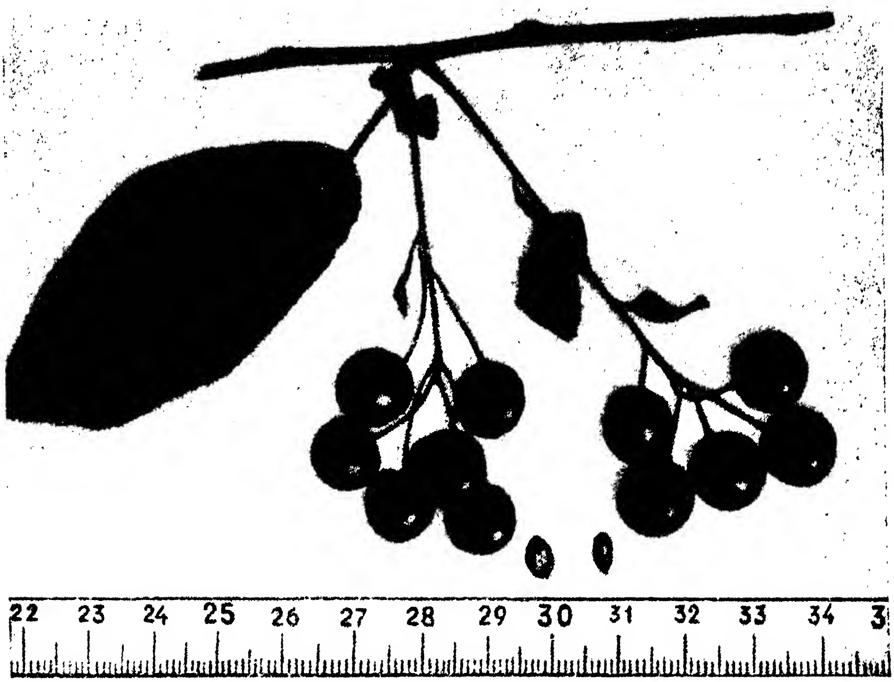


Fig. 166. Sweet Cerapadus (second generation)

Hybrid vigour is as strongly expressed in this variety as in the other Cerapadus types I have produced—luxuriant growth, powerful development of both the aerial and the root system, and a dense, firmly compact round-topped crown give this new hybrid a healthy, flourishing look.

Shape of fruit: round, with the base very slightly flattened; outline absolutely even; suture indistinct; fruit very slightly flattened on the suture side; the base of the style not so noticeable—most of the fruits have no depression there.

Colouring: nearly black, of a lacquered shininess, and the same over the whole fruit, except that along the suture there is a barely noticeable lighter

stripe, which may be narrower or wider; the skin is thin, elastic, tears with difficulty, and is free of the flesh.

Size: length 12 mm., diameter 11 mm., weight 1 gr.

Stem: slender, 16 mm. long, pale green; the fruits grow in a cluster, hanging on a peduncle 48 mm. long, to which they are firmly attached. The stem is placed in a shallow, wide, regular cavity and is pretty firmly attached to the fruit.

Stone: very small, full, pink in colour, and of an irregular oval shape, with the lower end narrower than the upper and the obtuse ridge, somewhat more prominent than the sharp one. Fairly well-marked blades project from the point of attachment to the stem and the obtuse lateral ridge; in some of the fruits, however, they are scarcely noticeable.

Flesh: black, firm, sour-sweet (the bitterness only very slight), with a piquant flavour; the juice is deep red and stains heavily; the flesh is succulent and the stone clings.

Ripening time: latter half of July.

Properties of tree: at the age of five years reaches three metres, the tree's general appearance is a compact, healthy one. It is definitely hardy against our severest frosts, does not suffer from any diseases, the bark scales as in the case of all Cerapadus types, the yield is extraordinarily abundant.

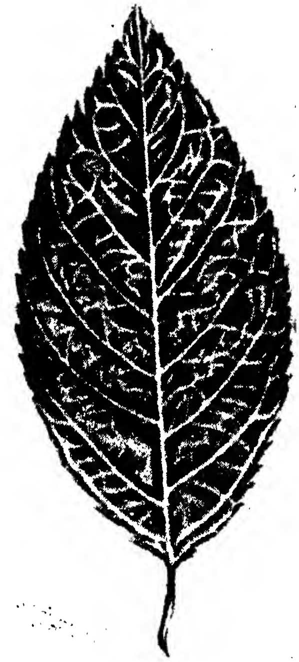


Fig. 167. Leaf of Sweet Cerapadus

This type will be of enormous value in hybridization work for breeding productive, cold-resistant, sweet varieties of sour cherries.

1932

SWEET CHERRIES

PERVAYA LASTOCHKA

I got this variety by planting a stone of Lauermann's sweet cherry in 1891. The first fruiting occurred in 1905, in the seedling's fifteenth year. The fruits on this occasion were only half as large as in the second fruiting year (1906).

This hardy variety, which I have bred by planting the stone, is added proof that the severe climatic conditions in our parts need be no obstacle to securing new hardy sweet-cherry types. Although the town of Michurinsk, in the environs of which the nursery is located, lies 500-600 kilometres north of the sweet-cherry distribution area, it is possible to have here sweet-cherry

varieties so fine as freely to endure the competition not only of our Crimean types, but even of foreign varieties from western countries.

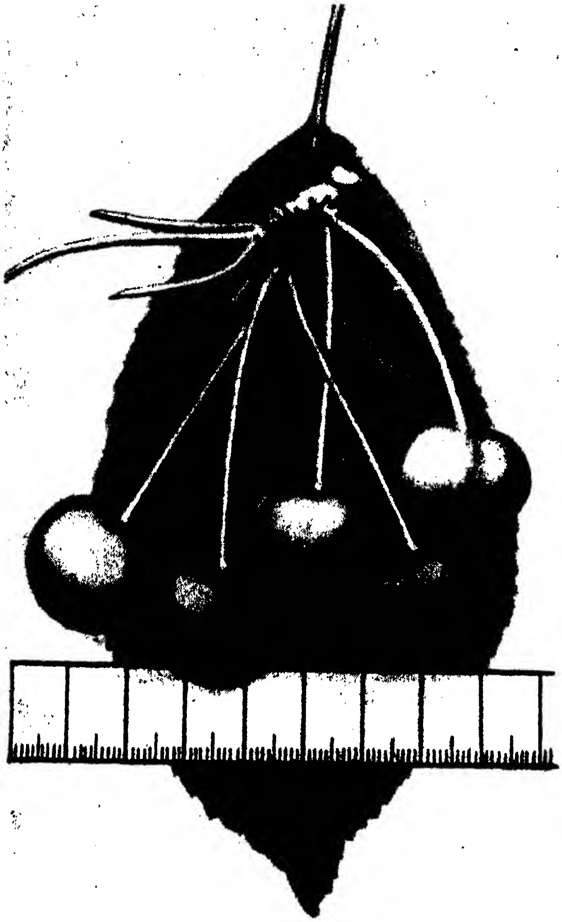


Fig. 168. Pervaya Lastochka sweet cherry

Shape of fruit: cordate, with a noticeable suture along the axis; the contour is even.

Colouring: yellow, with a flush on the side exposed to the sun; the skin is shiny, with a translucent look in parts that makes the fruit appear transparent; .it is strong and elastic, tears with difficulty and adheres to the flesh.

Size: length 19 mm., diameter 22 mm., weight 4 gr.

Stem: long, sometimes fully 50 mm., of medium thickness, slightly curved. firmly attached to the fruit spur and very firmly to the stone; it is placed in a wide, shallow, regular cavity.

Stone: round, white, smallish and well developed.

Flesh: tender and very juicy, so that this variety should rather be classed with the Guignes than with the tougher Bigarreau types.

The flesh is delicious, with a refreshing sweet flavour, the juice is of light colour and does not stain. Stone is free.

Ripening time: very early, in the first half of June.

Properties of tree: the stature is low, no more than two or three metres—an extremely rare thing among sweet cherries, and one making for very convenient picking, which is not the case with many of the new sweet-cherry varieties I have produced, as their height not infrequently exceeds six-seven metres. That is characteristic of sweet cherries in general, with the result that it is practically impossible to pick the crop from the upper parts of the crown; moreover, birds, who are very partial to the sweet fruits, destroy them faster on such tall trees than on low-growing varieties, on which these feathered pilferers are easier to combat.

In severe winters, the trees suffer from the frost. There are no offshoots from the roots.

The leaf blades are rather large; they exhibit no special differences as compared with the leaves of other sweet-cherry varieties.

Fruit bearing is generous.

As a parent plant, this type has great value for breeding in our parts new hardy interspecific sweet-and-sour cherry hybrids.

1932

PERVENETS

This fairly hardy sweet-cherry variety is represented by a seedling chosen for its greater hardiness among some raised in the spring of 1901 from stones of the Black Friedrich sweet cherry. The seedling's first fruiting was in 1906, in its sixth year of growth.

Shape of fruit: round-cordate or slightly conical, the contour uneven, with obtuse ribs, and with dents and additional riblets scattered all over the fruit. The base of the style is distinctly visible and lies in a rather deep depression.

Colouring: uniform blackish-red; showing clearly through the skin are light red flecks distributed unevenly over the fruit; they are of elongated form at the base and only small points near the apex. The skin is smooth and shiny, of medium thickness, adherent, inelastic and tears easily.

Size: length 28 mm., diameter 29 mm., weight 7 gr.

Stem: 43 mm. long, of medium thickness, slightly curved, fairly elastic and firmly attached to the fruit spur. It is pale green in colour, with only a slight redness near the fruit, and is very firmly attached to the stone.

Stone: well developed, and oval in shape; neither the sharp nor the obtuse ridge is prominent.

Flesh: firm in texture, with deep-red juice, succulent and entirely sweet in flavour.

Ripening time: first half of July. The keeping capacity of the fruits is as much as three months—an outstanding quality of this new variety of sweet cherry.

Properties of tree: in heavy clay soils, the crops are tolerable; but in meagre dry soils, while the tree is hardier, there is a marked deterioration in the yield. For breeding new hardy types of sour and sweet cherries, this is the best parent in the central part of the R.S.F.S.R., as it produces splendid hardy varieties not only by hybridization, but by simple planting of the stones.

It is suitable for hybridization in the breeding of new sour and sweet cherry types hardier than itself.

1932

CHORNAYA GORKAYA

This variety is derived from a stone of the Black Friedrich sweet cherry, which was planted in 1901. The seedling bore its first fruit in 1911, in its tenth year of growth.

Shape of fruit: obtusely cordate, the contour even.

Colouring: uniformly black; the skin is smooth and shiny, rather thick, and free of the flesh.

Size: length 18 mm., diameter 20 mm., weight 2.5 gr.

Stem: 34 mm. long, of medium thickness, slightly curved, and tenaciously attached to the fruit spur and the stone, so that there is no windfall as the fruit ripens; the stem is pale green in colour and is placed in a wide, shallow, regular cavity.

Stone: medium size, oval and well developed.

Flesh: juicy, firm, of Bigarreau structure and deep-red colour; it has a refreshing bitter-sweet taste.

Ripening time: the fruit matures completely in the latter half of July.

Properties of tree: the habit of growth is tall, the crown compact, of broad pyramidal form. The tree is quite hardy against the severe frosts of our central belt of the R.S.F.S.R. The yield is abundant.

In general, the tree has a strong, healthy constitution. It is very valuable to originators as a parent plant for breeding new sweet-cherry varieties.

The fruits of this new type are suitable only for kitchen purposes, particularly for making jam, to which a special piquancy is lent by the faintly bitter flavour exclusive to this variety of sweet cherry.

1932

PLUMS

PERSIKOVAYA

This variety had its origin in a seedling raised from a stone of the Belaya Samarskaya plum, which was sent to me from the town of Kuibyshev (by Reshetnikov in July 1904). The seedling flowered in 1912, and was fertilized that same year with pollen of the American Washington plum.

The resultant hybrid seedling produced its first fruits in its ninth year (1921).

Shape of fruit: round or round-oval, and varies but little; the contour is even, and the suture clearly marked, with gently sloping edges.

Colouring: yellowish-green when unripe and yellow with a greenish tinge when ripe. The surface pigmentation is faint, with a brownish-red flush.

Size: length 47 mm., diameter 45 mm., weight 35 gr.

Stem: medium thickness, 23 mm. long, medium curved, and of grasslike texture; in colour it is pale green with a silvery sheen due to abundant

pubescence. It is firmly attached to the fruit spur and is placed in a regular, shallow cavity.

Stone: medium size and sometimes quite small, with a rough surface. It is oval in shape, truncated at the base and coming to an obtuse point at the apex. The three ridges are well marked, between them are two deep furrows. The stone is firmly attached to the stem.

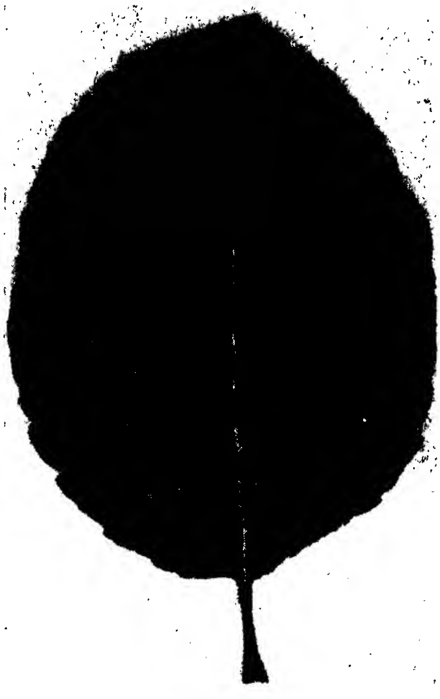


Fig. 169. Leaf of Persikovaya plum

Flesh: tender, loose and soft in texture and extremely juicy; in colour it is light, a greenish yellow. The flavour is a delicious peachlike one, sweet with the faintest touch of acidity. The stone is free.

Ripening time: end of August and the beginning of September.

Properties of tree: hardiness is insufficient, the yield good, but not every year. The tree needs a protected location and a sufficiently warm water-permeable soil, and cannot endure close proximity of ground subsoil water. It is of healthy appearance, the stature rather low. This plum is suitable for cultivation in the southern part of the former Tambov Province. A first-class variety.

REINE CLAUDE KOLKHOZNY

In the central and northern belts of the Soviet Union, there is not a single old plum variety at all deserving of attention.

True, there is much damson in our orchards and the fruits of some of the damson seedlings reach a considerable size, but these fruits are usually not fit for anything except preserving.

As to the old plum varieties to be found in our orchard assortment, most of them lack frost resistance and fruiting is irregular—one year the trees will fruit, and then for three or four years they will yield next to nothing.

Fig. 170. Leaf of Reine Claude Kolkhozny

As long ago as the eighties of the last century I gave this matter a good deal of attention and engaged in hybridization work to breed new plum varieties that would be hardy and would fruit every year.

Today, when success in the planting of vast socialist orchards depends to a large extent on proper choice of the fruit varieties for the locality in question, my Reine Claude Kolkhozny plum, described below, should prove of great economic value to the sovkhozes and kolkhozes when large tracts of orchard ground are planted with a single plum variety.

More than forty years ago, in 1889, I crossed Green Reine Claude with the damson.

The seed sprouted in 1890.

The first fruiting was in 1899, the seedling's tenth year of growth.

Shape of fruit: round, of the Reine Claude type, rather strongly oblate; the side next to the sharp ridge of the stone is in most cases somewhat better developed than that next to the obtuse; the contour is even, the suture fairly well marked; the base of the style is indistinct, it lies in a deep, rather narrow depression along the suture, looking towards the sharp ridge; the cavity has a slight nick, but this is not found in all of the fruits.

Colouring: uniform greenish-yellow; prior to picking, the fruit is covered with a bluish-grey bloom; the whole surface is sprinkled under the skin with small greyish-blue dots. The skin is rather thin, free and tears easily.

Size: length 33 mm., diameter 32 mm., weight 20 gr.

Stem: 20 mm. long, slender, pale green in colour, with sometimes a brownish-red flush on the side turned to the sun. It is not very well attached to the stone. The stem lies in a narrow, deep, regular cavity, it has a deep groove on the suture side.

Stone: small, full, a broad oval in shape; the suture is strongly marked on one side, making it rather asymmetrical. Along the sharp ridge, there is a deep, narrow groove between the shells. The contour of the stone is uneven, some stones have clearly marked processes issuing from the side where the stem is attached.

Flesh: pale green, prettily tinged with yellow; it is very juicy, absolutely sweet and not quite solid in texture; the slight bitterness of the skin gives the fruit a delightful piquant flavour; the juice colour is light.

In ripe fruits, the stone is free.

Ripening time: August 20-25.

Properties of tree: height reaches three metres, the tree does not suffer at all from diseases generally and is completely immune to fungous ailments. Gumming of the trunks has never been observed, and in general the tree is of a healthy, flourishing appearance.

Its hardiness against our severest frosts is remarkable.

Bearing is annual and generous.

A first-grade variety, deserving to be grown on the widest scale in our socialist economy.

1932

REINE CLAUDE REFORMA

Obtained by myself in 1889 from planting the stone of a damson whose flowers had been fertilized in 1888 with pollen of Green Reine Claude.

Reviewing the merits of this new variety, I can safely say that it has a splendid future in the central belt of the R.S.F.S.R. Besides having fruits with a flavour unrivalled by any of the plum varieties that grow without winter protection in our orchards, it has turned out to possess the valuable property of transmitting the fine taste of the southern Reine Claudes to nearly all its seedlings.

Examining a row of one- and two-year-old seedlings of this type, you will see only variations that have deviated wholly in the direction of the Reine Claudes, and not a single specimen deviating in its constitution in the direction of wild plum species.

True, such constancy has also been observed frequently in seedlings of certain other plum varieties, particularly if the stones were taken not from grafted trees, but from own-rooted trees propagated by layerage, and if these trees grew at a distance from semicultivated and wild species of plums.

But in the present instance the point of chief interest for us is that Reine Claude Reforma is the first typical and fully hardy southern plum in our orchards. In future, its seedlings will produce a number of fine large-fruited plum varieties for our parts.

On the basis of many years' practice in appraising the future merits of seedlings, particularly seedlings of stone fruits, I can without fear of error recommend this new Reine Claude as an excellent parent type for hardy Reine Claude varieties. From its seedlings, we may count on getting several

dozen Reine Claude strains differing for the most part only as to colouring and fruit size.

The first fruiting of the Reine Claude Reforma seedling occurred in 1906, in the seedling's eighteenth year. The reason why so much time elapsed between germination and fruiting was that in its tenth year the seedling was transplanted to a different site; and since all stone fruits have an aversion to transplanting and suffer from it a good deal, the first fruiting of Reine Claude Reforma was accordingly delayed.

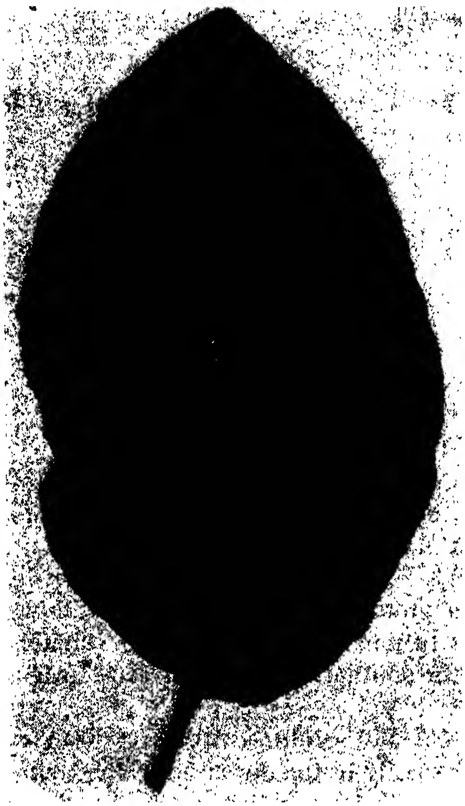


Fig. 171. Leaf of Reine Claude Reforma

An interesting thing was to be observed in this first fruiting: the fruits on the two main branches differed in size, weight and ripening time. Previously I had observed deviations of this type only as between different seedling specimens, and always in equal degree on all parts of the specimen; partial deviations (what is commonly known as "sport") are rather rare among fruit plants.

This case of Reine Claude Reforma indicates that when grafting new varieties raised from seed, particularly during their first fruiting years, great care is necessary in choosing the branches from which to take the cuttings, otherwise mistakes may easily occur, and wishing to propagate one variety, you may get an altogether different one. Then, the crops of the second and third years also showed the instability of the "sport variation," as the fruits of these and succeeding years exhibited no differences; they were all equally large and sweet and ripened at the same time.

All this makes it evident that if a "sport variation" is of interest to the originator, it must be fixed by grafting the very first summer it appears; the grafting should not be put off until the following year, otherwise the "sport" may be lost.

Shape of fruit: round; suture indistinct; the contour is even, the remains of the style lie in a barely noticeable depression.

Colouring: when the fruit is completely ripe—an amber yellow, with greenish streaks on the side away from the light. The whole surface of the

Table V. Reine Claude Reforma plum with parent plants: right—Reine Claude Reforma; upper left—Green Reine Claude; below—damson

fruit is flecked with whitish dots and covered with a white bloom that comes off easily. The skin is rather thick and free of the flesh.

Size: length 42 mm., diameter 43 mm., weight 30 gr.

Stem: up to 40 mm. long, of medium thickness, slightly curved, grasslike in texture and firmly attached to the fruit spur; it is pale green with brown flecks, has no pubescence and is but lightly attached to the stone.

Stone: medium size, somewhat asymmetrical, of obtuse oval shape. The base is rounded, with a pointed tip (although this character varies); the sutures are wide, with deep dents; the surface is very rough and ripply. Most of the stones have a sharp ridge on the outer side along the axis of each shell; this is characteristic of the variety. This latter property is very important when the fruits are processed in confectionery factories.

Flesh: yellowish green and fairly soft; when ripe, it is extremely juicy and sweet, with an agreeable touch of acidity. The stone is free.

Ripening time: first half of August; when the summer is late, it shifts to the latter half of August and sometimes extends even into the beginning of September.

Properties of tree: growth is slow, stature relatively low, habit bushlike and somewhat spreading. The shoots are thick and short, with very prominent bud cushions or pulvini, of a greenish brown. The leaves are large, crinkled and dull green in colour; the underside of the blade, particularly the midrib near the petiole, is covered with a down which disappears by the time the fruits reach maturity.

The tree is hardy and produces a medium yield; it sends up root growth that can be used quite well to propagate this new variety.

In view of its delicious flavour, large fruit-size and free-stone property, the variety must be rated a first-class commercial one.

1932

REINE CLAUDE TERNOVY

This is a variety I obtained by fertilizing Green Reine Claude with pollen of wild blackthorn.

The seed sprouted in the spring of 1910.

The first fruiting occurred in 1916, the seventh year of the seedling's growth.

Shape of fruit: round, of the Reine Claude type, suture indistinct; the contour of the fruit is even.

Colouring: the ground colour of ripe fruits is dark, a blackish purple; there is, however, a distinct tawny tinge to it, and this is the stronger, the less ripe the fruits; the colouring appears mottled because of numerous fairly large whitish flecks covering the fruit. The skin is thick and strong, tears with difficulty and is free of the flesh.

Stem: 26 mm. long, medium thick and slightly curved; it is of rather firmer grasslike texture and strongly attached to the fruit spur. In colour it is pale green with a faint yellowish tinge, with sometimes a brick-brown flush on the side turned to the sun. Attachment to stone tenacious, so that there is never much windfall; the stem sits in a small, shallow cavity.

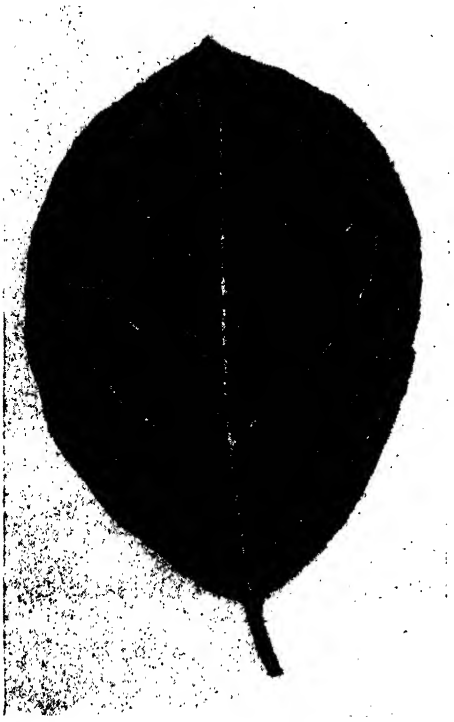


Fig. 172. Leaf of Reine Claude Ternovy

Stone: small, of the oval shape typical of Reine Claude; it is asymmetrical and is nicely rounded on top, as the point is obtuse and does not protrude sharply. The dorsal suture is extremely thick, with the edges of the individual ridges very obtuse, and well-marked shallow furrows between them; the ventral suture is somewhat sharper and a deep groove cleaves it in two.

Flesh: pale green just tinged with yellow; very compact, sometimes actually crackling when bitten, and moderately juicy. In flavour it is agreeably sweet, with a faint acidity and tartness which gives it a distinctive piquancy. The stone is free, barely adhering on the dorsal side.

Ripening time: beginning of September.

Properties of tree: spreading, yet compact habit; short stature; undoubted frost resistance; the yield scanty; immunity against fungous diseases is good.

The fruits are suitable not only for preserving, but also as dessert.

A second-grade variety.

1932

TYORN DESSERTNY

This variety resulted from fertilizing wild blackthorn with pollen of Green Reine Claude.

The seed germinated in the spring of 1898.

The seedling's first fruiting was in its seventh year of growth, in 1904.

Shape of fruit: nearly round oval; the contour even, the suture well marked, but not deep.

Colouring: reddish brown with a purple tinge; in overripe fruits, the colouring is more intense—a purplish brown tinged with red.

The fruit is covered with a bluish bloom; the skin is medium thick and close in texture, but tears very easily and is adherent. Showing through it are large numbers of round muddy-yellow flecks, sometimes they make the fruit look mottled.

Size: length 26 mm., diameter 25 mm., weight 10 gr.

Stem: thick, curved but slightly or not at all; its structure loose, grass-like. It is pale green in colour and has no pubescence. Near the fruit there is sometimes a carmine-brownish flush, but much more often it has warts of a yellowish-brown colour.

The cavity is almost imperceptible. The stem is firmly attached to the fruit.

Stone: very beautifully shaped, regularly elliptical with the points projecting but slightly; it is of medium size. The ridges are indistinct, although the dorsal one is broad; all the ridges are obtuse, two extra dorsal ones stand out but slightly; the ventral ridge is cleft in two by a shallow groove.

The stone adheres to the stem, so that there is practically no windfall.

Flesh: yellow tinged with green, and close in texture, but turns softer after lying in storage for a short time; it is not very juicy and the juice is colourless; the flavour is tartish-sweet, agreeable, but inferior to that of Tyorn Sladky.

Ripening time: first half of September.

Fig. 173. Leaf of Tyorn Dessertny

Properties of tree: stature fairly tall, the crown spreading and densely foliated. The tree is of healthy appearance, quite hardy against our frosts and bears good crops.

When fully ripe, the fruits often split, but this never leads to rotting.

A first-class variety.

1933

TYORN SLADKY

In the spring of 1889 I pollinated some flowers of a four-year-old blackthorn (*Prunus spinosa L.*) with pollen of Green Reine Claude.

The stones were planted in the spring of 1890.

Out of the resultant hybrid seedlings, I chose the one closest to Green Reine Claude in appearance, and grafted buds of it in 1891 on the root neck of a three-year-old pure blackthorn seedling.

In the further development of these two specimens—the original hybrid seedling from which the buds were taken and the graft of it on the blackthorn—a pronounced difference showed in their appearance, and as time went on it became ever more marked.

The graft was very much behind in growth, and all parts of it changed for the worse. Both the shoots and the leaves diminished considerably in size and lost their pubescence.

The shape of the leaf blades changed from round to oblong, the crenate leaf margin to a serrate one, and so on.

In 1896 the graft bore its first fruits, but they were both small and inferior in flavour.

The hybrid vegetative parent fruited for the first time only in 1898.

Its fruits had nothing in common with those of the graft as regards their qualities.

The two trees remained in this position until 1899, when the whole nursery with its already adult seed-grown trees was moved to a new location, and this hybrid seedling and its graft had to be transplanted with the rest. The graft I deliberately planted with the point of union well below ground. Afterwards, by maintaining the moisture supply, I succeeded in making the tree put forth roots of its own, which fortunately developed so well that in the spring of 1903 it proved possible, by digging under one side of the tree, to cut away a considerable part of the roots of the blackthorn stock, and in 1904 I was able to remove the remaining wild blackthorn roots altogether.

But evidently the constitution of the tree had been so altered and the change partially fixed to such an extent that in spite of the, in my view, complete replacement of the root system, the fruits of the 1903 and 1904 crops were no different in their properties, and not until the crops of 1905 and 1906 did they improve so far as to make this new vegetatively-produced variety fully worthy of propagation.

I repeat, the variety we got was a completely new one, totally different in its properties from the seedling it had been derived from by grafting; for the fruits, leaf-shape and other features of the former graft had nothing in common with the corresponding features of the seedling from which it was derived.

This fact, which is well worth studying, undoubtedly proves that the influence of the stock upon the scion can sometimes be so strong as to alter a young grafted hybrid variety beyond all recognition.

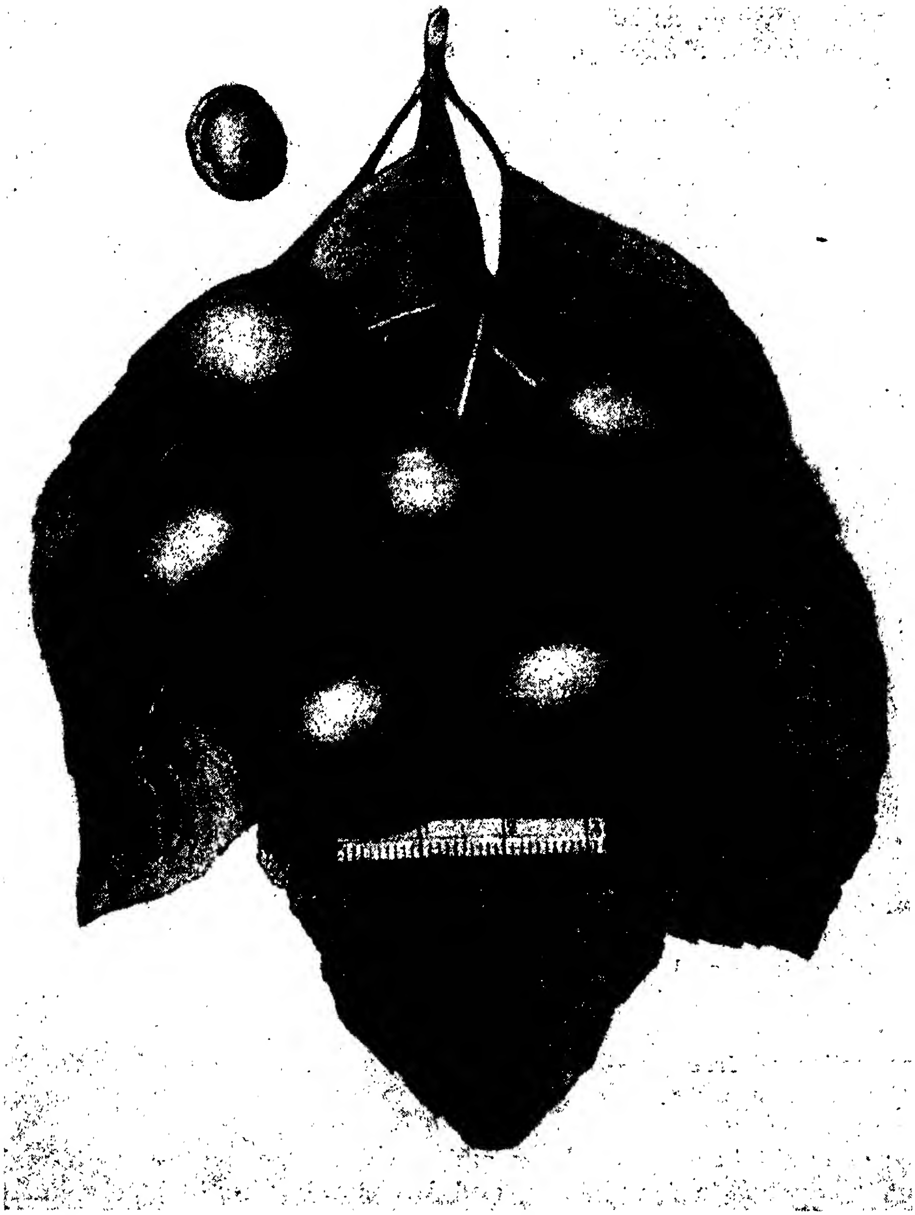


Fig. 174. Tyorn Sladky

I describe instances of this kind in order to bring home more fully that new varieties can be obtained not solely and exclusively by sexual crossing, but vegetatively too, as for example by grafting, and that not every method of propagation always preserves the distinguishing characteristics of a variety.

Under ordinary conditions facts of this sort are rare; but that is evidently because in the usual grafting for propagation purposes, it is always old, long-standing, fixed varieties that are used. Moreover, wildings of the youngest possible age are taken as stocks. And so in these instances it is only the scion that can manifest its influence on the stock, not the other way round.[1]

It is only in nurseries of plant breeders, where new varieties are often propagated by grafting at a very early age, before they have had time to develop sufficient resistance to change, that the influence of the stock upon the grafted variety may be seen with greater frequency.

I shall now describe the characters and properties of this new variety, which I have named Tyorn Sladky.

Shape of fruit: round, slightly oblate and somewhat angular; suture indistinct; the contour is even, except that overripe fruits turn wrinkled and uneven; the remains of the style lie in a wide, shallow depression, forming a small yellowish spot.

Colouring: dark purple-blue, with a heavy bloom of whitish blue, and with grey-white flecks showing faintly through the skin. The skin itself is fairly thick, free of the flesh, resists tearing, but is not elastic.

Size: length 26 mm., diameter 28 mm., weight 12 gr.

Stem: 15 mm. long, of medium and sometimes greater thickness; it is slightly curved, of loose grasslike texture, and pale green in colour, without pubescence. It is ill-attached to the stone, and so the fruits tend to shed as they ripen.

Stone: small, of round flattened shape, with rough surface, clinging.

Flesh: firm, green in colour, with an indistinct tinge of yellow; the flavour is remarkably agreeable, with a peculiar piquant tartness possessed by this variety alone.

Ripening time: end of August and the first half of September.

After being picked, the fruits keep without difficulty for over four months under ordinary home conditions.

Properties of tree: medium height, compact habit, complete frost-hardiness. Crops in sandy soil are medium. The tree sends up root growth that can be used for propagation. It is not given to gumming.

The splendid keeping qualities and good flavour of the fruit, which is absolutely invaluable for pickling and jam making, undoubtedly make this a first-class commercial variety.

1932

[1] This mostly passes unnoticed, only in rare cases does one observe that, after an old fruiter dies, the roots put forth wild shoots which produce good fruit of a totally different kind from the grafted variety.

CHERNOSLIV KOZLOVSKY

This variety was obtained from the seed of a damson fertilized in 1893 with pollen of the plum Anna Späth.

The first fruiting was in 1901, the eighth year of the seedling's growth.

Shape of fruit: irregular oval with prominent bulges; the apex has no depression and comes to a sharp point.

Colouring: dark purple, with large numbers of small pale-grey dots showing through the skin, which is covered with a fairly heavy blue bloom.

The skin is rather thin, but strong, and peels readily from the flesh.

Stem: medium thickness, 20-26 mm. long, slightly curved, of grasslike texture and firmly attached to the fruit spur. It has no pubescence and is pale green in colour, with sometimes a carmine-brownish flush. It sits in a shallow cavity at the start of the suture; attachment to stone tenacious.

Stone: large, of irregular elliptical shape, with sharp ends and the sides much flattened.

The dorsal ridge varies greatly, from a sharply prominent to a much blunter one; the lateral ridges are indistinct.

A deep groove runs down the ventral side, and one narrow furrow down the dorsal.

Flesh: pale greenish-yellow, firm and fairly succulent, with yellowish-green juice; it has an agreeable sweet subacid flavour and separates readily from the stone.

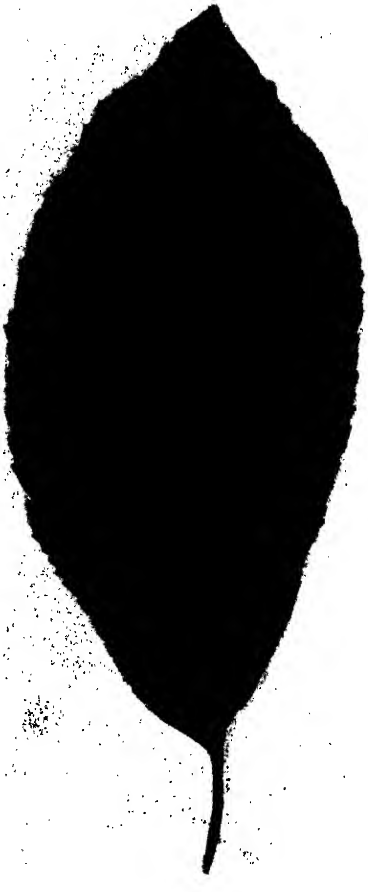


Fig. 175. Leaf of Chernosliv Kozlovsky

Ripening time: end of August and beginning of September.

Properties of tree: growth is slow, stature low, crown wide. The shoots are thick, with prominently bulging bud cushions, the colour dark brown. The yield is good. The tree is definitely hardy against our severe frosts.

A splendid commercial variety suitable for processing.

1933

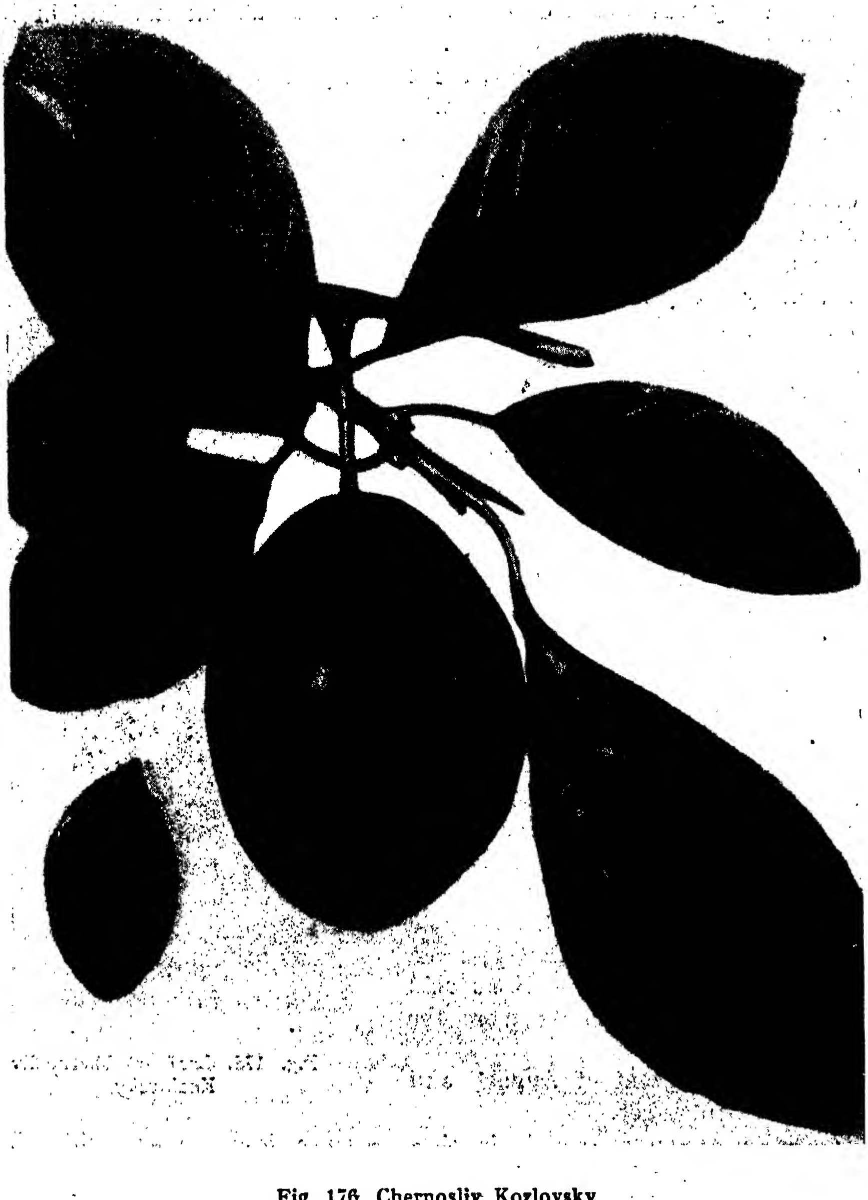


Fig. 176. Chernosliv Kozlovsky

APRICOTS

MICHURIN LUCHSHY

This variety was obtained by selection from seedlings of Siberian species of apricots (*Prunus sibirica L.*) which had been sent to me from Blagoveshchensk in the autumn of 1925.

The seeds germinated in the spring of 1926.

The first bearing was in 1931, although the first profuse blossoming had taken place in 1930. But the severe morning frosts in the spring of that year, which reached -8° C., not only completely destroyed the flowers of this variety but did enormous damage to other species of fruit plants, such as apples, pears, plums, etc., the crops of which were greatly reduced in many of the orchards of our region.

This new variety now lays a firm foundation for the cultivation in the central and northern zones of the Soviet Union of a supremely frost-hardy apricot with a good tasty fruit.

The severe frosts that swept the whole of Europe in the winters of 1928 and 1929 killed practically all the old, long-standing varieties of fruit plants in some of the orchards of the R.S.F.S.R. Yet these exceptional frosts did not harm this variety of apricot in the slightest, and even the tips of a luxuriant one-year growth were not in the least damaged.

The fruit buds in this variety develop on all the branches of the tree, not excluding the summer growth, and so profusely that when performing summer bud grafting it is quite impossible to find a single shoot with growth buds that could be fully used for budding.

Michurin Luchshy will also be of immense value for the hybridizer, since crosses between it and the best Manchurian large-fruited apricot varieties may provide us with a number of fine new frost-resistant varieties.

Shape of fruit: ovate, flattened at the top and bottom; unequal sides, with the dorsal part of the blunt ridge of the fruit more prominent than the sharp side, which is somewhat drooping; even contour; strongly-marked suture.

Colouring: uniform golden yellow, with tiny whitish spots stippled over the whole surface of the fruit, which is covered with a light down. The skin is thick, spongy, easily tears, and clings firmly to the flesh.

Size: length 20 mm., diameter 28 mm., weight 10 gr.

Stem: short, thick and set in a deep elliptical cavity.

The stem is attached to the stone fairly firmly. On the blunt ridge side the cavity forms a deep depression which stretches, in the form of a suture, to the very base of the remains of the style, the latter being clearly distinguishable in the shape of a black protruding spot. This base lies in a fairly marked depression.

Stone: round, with the blunt ridge slightly raised, and the upper end of

the sharp ridge markedly protruding. Both the blunt and the sharp ridges are very distinct.

The stone is free.

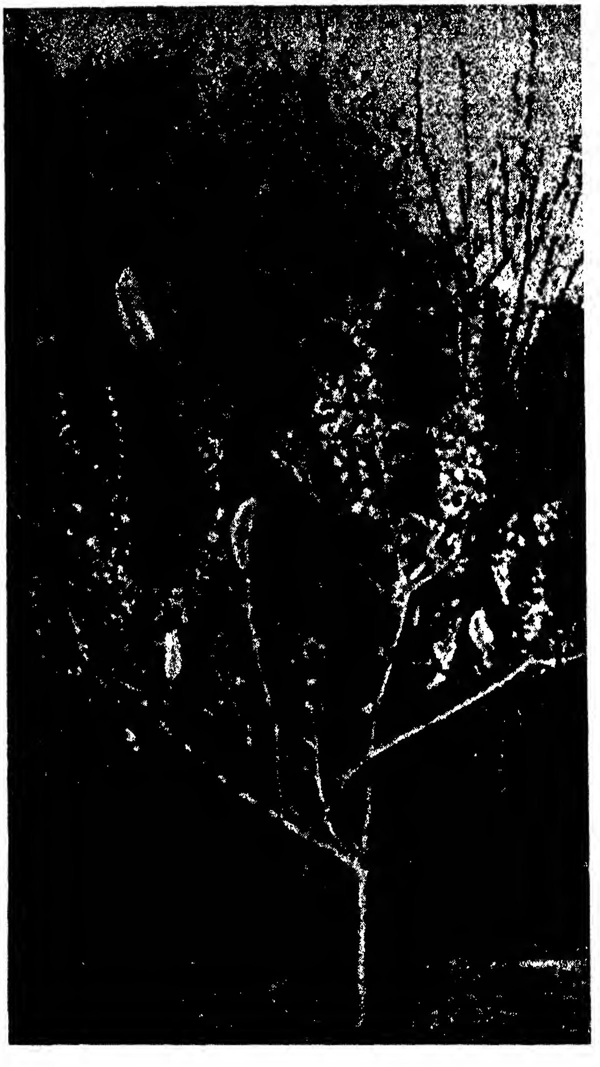


Fig. 177. Michurin Luchshy apricot tree in bloom

Flesh: of a handsome yellow colour and fairly firm, slightly friable, very sweet and with a faint piquant bitter flavour, which it derives from the skin.

Ripening time: middle of July.

Properties of tree: tall, attaining to 3 m. at the age of six; extremely frost-hardy and immune to gummosis.

An exceptionally fine variety for our regions of the central zone of the R.S.F.S.R. Suitable for mass propagation in sovkhozes and kolkhozes. In

Fig. 178. Blossoms of Michurin Luchshy apricot

Fig. 179. Leaf of Michurin Luchshy apricot

localities not very liable to early and spring frosts, it is recommendable for cultivation not only for canning, but for use as a dessert, in view of its splendid taste.

1932

MONGOL

I obtained this variety by selection from seedlings of a Mongolian apricot, the stones of which were sent to me in 1913. The seed sprouted in the spring of 1914.

The seedlings first bore in their eighth year, i.e., in 1922.

Shape of fruit: an elongated oval, not quite regular, the dorsal part fairly prominent; even outline; deep suture, especially in the lower part, where it practically dissects the fruit.

Colouring: yellowish orange, lustreless, especially in upper part; the surface of the fruit is covered with tiny spots creating a dark carmine flush; the skin is covered with down.

Size: length 36 mm., diameter 28 mm., weight 16 gr.

Stem: very short, 4 mm. long, set in a very deep, broad and regular-shaped cavity; the stem is attached to the stone loosely, and the fruits therefore readily fall when ripening.

Stone: oblong shape, as in the common plums; tip rather sharp but small; the sharp dorsal ridge has two deep furrows; the ventral ridge is blunt.

Flesh: light-saffron colour, soft consistency, juicy, sweet, with a pleasant acidity and aroma, very fragrant; clings firmly to the stone.

Ripening time: beginning of August.

Properties of tree: average height. In general, the best locations in the central zone of the R.S.F.S.R. for the cultivation of Mongolian apricot varieties are steep slopes, particularly westerly, then northerly, and only in case of extreme necessity southerly or easterly.

Open, flat and entirely unprotected lowland is altogether unsuitable, because of the tendency of the plants to start a second sap movement in the rainy and damp autumn season, owing to which the unmatured wood of the shoots is liable to be injured with the onset of the frosts. In the homeland of the plants, their brief vegetative period coincides with an equally brief summer period; moreover, the apricot groves are to be found exclusively on hill slopes, with a friable soil of weathered limestone, where they can stand more than 38°C. of frost. On the hills in the vicinity of Nerchinsk, the variety of this apricot known as the *Prunus sibirica L.*—the fruit of which has a dry, inedible flesh, and whose leaf is narrower and longer in shape—can stand frosts as low as 50°C.

The varieties obtained in the first generation from Mongolian stones require, in conformity with the climatic conditions of their native land, a not very fertile soil and an elevated location. Grafted on the crown of plum trees, they develop excellently in growth, become more frost-hardy and blossom a week later, which is very important in saving the flowers from injury from late spring morning frosts. They can be crossed with plums only at the time of the first blossoming both of the apricot and the plum seedlings, and the latter must be exclusively of large-fruited varieties, e.g., Pontbriant, Reine

Claude Reforma, Washington, White Egg, etc. Eminently suitable in all respects for crossing with this variety is the southern cultivated Pêche apricot, which is distinguished for the constancy of its seedlings, and especially for the largeness and excellent taste qualities of its fruits.

The variety is first-grade in all respects.

1932

SATSER

This rare species of apricot was developed from stones obtained from the grounds of a Buddhist monastery in Mongolia, near the station of Utszima and the village of Kua-Tsotenza. The trees grew over the tombs of members of a dynasty that once ruled in China.

The stones were received in the autumn of 1913, and sprouted in the spring of 1914.

The select seedling began to bear in 1922, in its ninth year.

Shape of fruit: round, sometimes slightly flattened, but always handsome and regular-shaped; even outline, with a suture that is less marked than in other apricot varieties. The apex of the fruit is beaked.

Colouring: dull, saffron-yellow with a greenish hue; upper part of the sunny side flushed with raspberry-coloured spots. The surface of the fruit is lustreless and downy.

The skin is rather thick, but spongy, and clings firmly to the flesh.

Size: length 30 mm., diameter 30 mm., weight 13 gr.

Stem: very short, 5 mm. long, set in a deep, broad, regular-shaped cavity. The stem is loosely attached to the stone, so that the fruits readily fall from the tree when ripening.

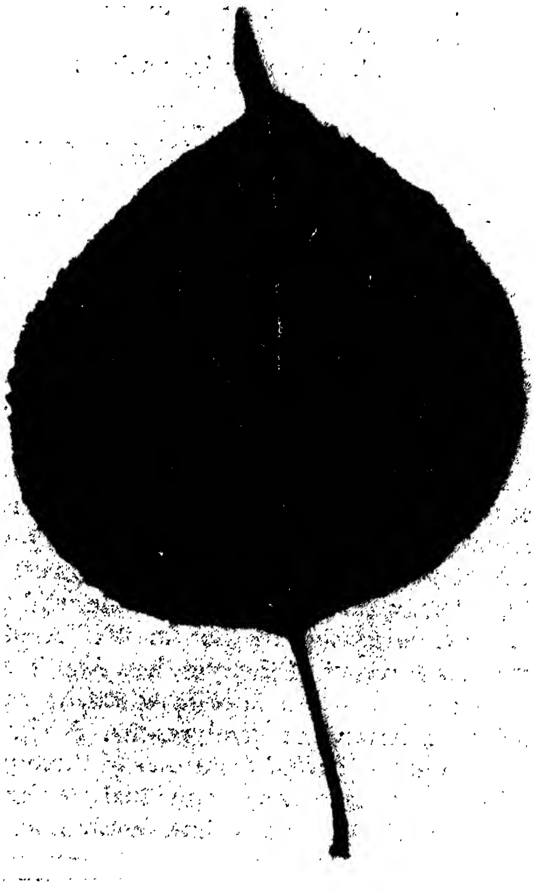


Fig. 180. Leaf of Mongolian Satser apricot

Stone: of a broad oval, almost circular, shape; sharp dorsal ridge; some of the lateral ridges faintly marked; blunt ventral ridge. The stem makes a semicircular shallow depression in the stone.

Flesh: juicy, orange-yellow, with a saffron hue; fairly firm in not altogether ripe fruits, and soft in ripe fruits; sweet taste, with a pleasant, hardly distinguishable acidity; clings firmly to the stone.

Ripening time: first half of August.

Properties of tree: fairly hardy, prolific, and not very tall, attaining to 2-3 m.; healthy appearance, resistant to disease. The crown is broad and spreading.

It differs from all other seedlings in that its leaf is thick and leathery, of a darker green and brilliant colour, and with four glands on the stalk.

Suitable for canning and preserving (because of its high sugar content) and for dessert.

A first-grade, commercial variety.

1932

SEVERNY APRICOT

A NEW HARDY VARIETY FOR CENTRAL RUSSIAN REGIONS

Here is another big victory in the realm of acclimatization of southern plants, one that gives us every hope of having in our Tambov Province cultivated varieties of apricots that need no protection in the winter—something that only a little while ago we could not even dream of. All, even wild Siberian varieties of apricot have proved to be unhardy in our parts. As to the cultivated varieties, of the type of the true apricot, *Prunus armeniaca*, there was nothing to hope from them, because the northernmost boundary of their possible cultivation in the open lies seven hundred versts and more to the southwest of us. The development of a hardy apricot variety in our parts was an extremely difficult problem, it being impossible to acclimatize this species of fruit plants because of the fact alone that, as I have said, there was not a single hardy variety even among the wild forms of the species. Crossing with a view to increasing the hardiness of seedlings of cultivated apricot varieties was therefore out of the question. And in spite of the large number of plantings I made of the stones of southern cultivated varieties and of the wild apricot, I never got good results. Several tens of thousands of seedlings perished at the age of from one to three years.

We know that every individual species of plant and its varieties (in this case the apricot) has a definite borderline, beyond which, when planting one generation only, the plant cannot be transferred and successfully acclimatized. Naturally, the borders of this area may vary considerably, depending on the conditions of the locality to which the plant is transferred, on the composition of the soil and its humidity, and on the degree of difference of climatic conditions. To this should be added that the limits of advancement in one direction may be set by certain climatic factors, and in another direction by others. Lastly, much also depends on the individual qualities of the plant it-

self that is chosen for acclimatization. In the given case, it is obvious that for existing apricot varieties seven hundred versts in a northeasterly direction already far exceeds the limit.

Basing myself on this conclusion, I adopted the method of acclimatization by which the planting of the stones is advanced northward gradually. But as the great length of time required for this procedure made it impossible for me to undertake it personally, I willy-nilly had to look for the most northerly offspring of this fruit species in the near-lying provinces to the south and southwest of the Tambov Province, with the object of obtaining stones of this variety for planting in my orchard. I found nothing suitable in the southern parts of the Tambov Province or throughout the Kursk, Kharkov and Saratov provinces. But in the middle section of the Voronezh Province and the northern section of the Don Region, I discovered two new varieties of apricot recently developed from seed and already bearing. Unfortunately, it was already too late that first year to obtain stones of these varieties, and I therefore used only cuttings. But, as was to be expected, I failed to acclimatize either of the varieties by means of grafting. In the open, the young grafts were killed by cold, just as were all their predecessors. But about two years later I obtained stones from the homeland of the Don apricot, as well as from fruits of the Voronezh apricot which had ripened on a grafted specimen I had grown in a pot. When these were planted, out of several dozen seedlings I got two that were hardy.

I shall in this article describe only one variety that is hardy in our parts, the one I obtained from the stones of fruits that ripened on the grafted pot-grown Voronezh apricot. Its fruits turned out to be fairly large, but their taste qualities were extremely unsatisfactory. Nevertheless, knowing from experience that the direct and immediate parents (father and mother) have a very small influence on new varieties grown from seed, which are entirely influenced by more remote ancestors, and remembering that the owner of the Voronezh apricot had told me that he had developed the variety by planting stones from the fruits of an apricot that had excellent taste qualities, I had every reason to hope that among my seedlings I would find a hardy variety with fruits of good taste. This was brilliantly confirmed in practice. Because of its outstanding hardiness, I have named the new variety the *Severny* (*Northern*) *apricot*. I shall give its pomological data and illustrate its fruits, stones, twigs and leaves by a photograph in natural size.

Origin: developed in I. V. Michurin's nursery, Kozlov, Tambov Province, in 1901, from the stone of an apricot variety acclimatized in the Voronezh Province. The seedling bore its first fruits in 1906, i.e., in its sixth year.

Shape and general appearance of the fruits: of average size, round, with a clearly-marked, but not very deep suture. (As to the size of the fruit, it should be borne in mind that these are fruits of the first harvest, and that in the case of all species of stone-fruit plants, the first fruits of varieties developed from seed are considerably smaller, but gradually increase in size in subsequent years of bearing.)

Stem: very short, thick and downy.

Skin: covered with a soft down and fairly thick; bright-yellow colour, and handsomely stippled on the sunny side with closely-spaced purple spots. The skin of fully ripe fruits emits a strong fragrance resembling that of mignonette. The skin firmly clings to the flesh.

Flesh: extremely juicy, soft and with a fine, pleasantly sweet taste which a slight acidity saves from being cloying.

Stone: average size; dark-brown colour; slightly roughened surface; oval shape; fairly plump, with broad sharp suture ridges; clings firmly to the flesh.

Ripening time: beginning of July, with all the fruits ripening simultaneously. After gathering, the fruits keep for about a week.

Properties of tree: height at six years, four arshins. The branches are compact rather than spreading. The shoots are of average thickness and of a shiny dark-brown colour. The leaf is of approximately average size, of broad conical shape, with a slightly elongated tip of a lustreless dark-green colour; crenate leaf margin. The petiole is fairly long and thick, of a dark-red colour, with feebly-marked warty swellings. The fruit buds are arranged in groups of five or six. The blossoms are pure white, 3½ centimetres in diameter, with five petals and about twenty-eight stamens; the pistil rises ½ centimetre above the stamens. Blossoming time this year was on April 18. The fruits required eighty days of clear, dry weather for their full development and ripening. The yield is abundant. For six years the tree grew on a dry silty-sandy soil in an entirely open location; the nearest trees were ten sazhens away. No protective devices were employed in the winter. The soil under the tree was not loosened nor manured. And in spite of the fact that in the six-year period of its growth there were some relatively severe winters, with the temperature falling to 29°R. below zero, the only signs of injury from frost were the loss of the tips of immature shoots of a late second growth, and slight damage to the lower part of the trunk, giving rise to gummosis, which I partially succeeded in eliminating by cutting grooves in the trunk. Actually speaking, these data do not yet provide a sufficient guarantee to warrant bold propagation of precisely this variety in our regions, particularly on black-earth and heavy soils. Suitable varieties are to be expected only in the third and fourth generations. Nevertheless, I consider that this new variety represents a big step forward in the acclimatization of the apricot in our parts.

When this year my two hardy varieties blossomed simultaneously, they were mutually crossed. The stones obtained are of course of great value for acclimatization purposes, for which reason I was unable to send the editors specimens of the fruits, and confined myself merely to a photograph and a descriptive article.

In conclusion, it may not be superfluous to add the following explanation to this article, in which many may discern certain contradictions. Although I said that the influence on the offspring of the direct and immediate parents, i.e., father and mother, was not very great, and ascribed the full influence

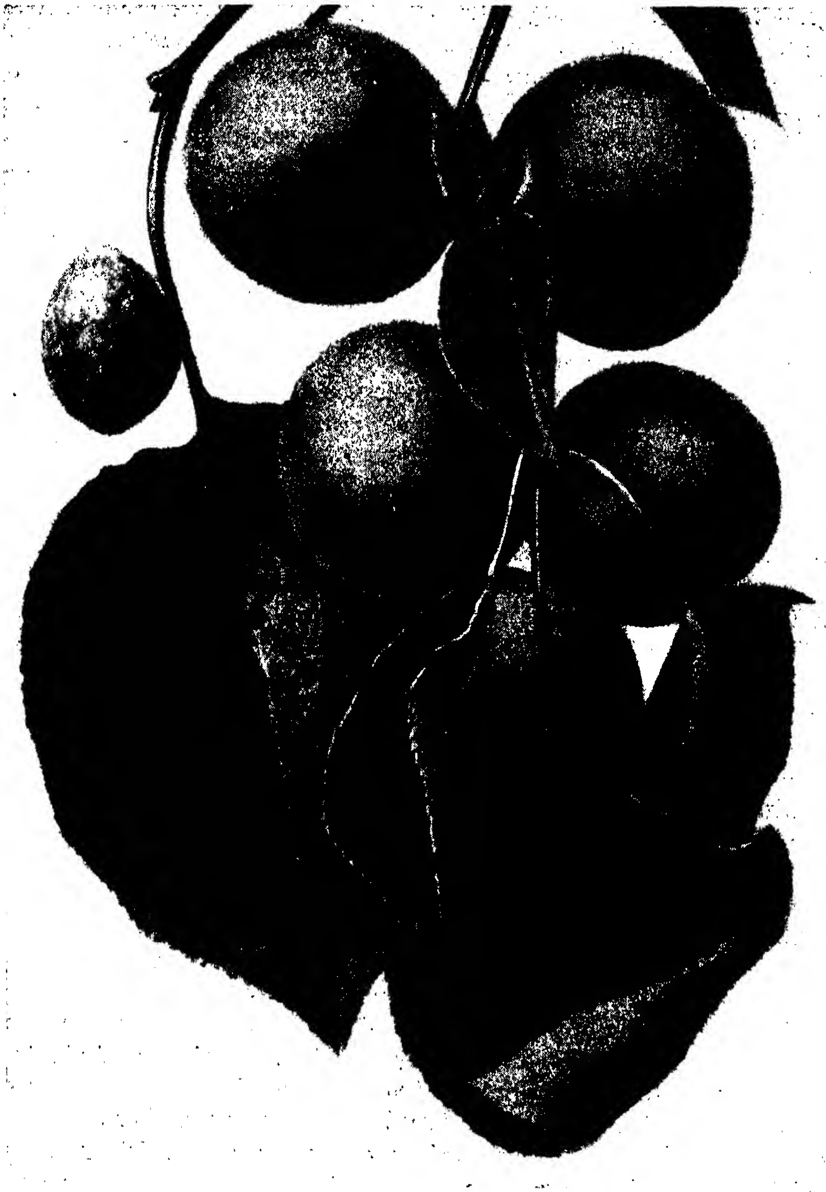


Fig. 181. Severny apricot. Hardy new variety for Central Russia

of hereditarily transmitted qualities to more remote progenitors (grandfather and grandmother, if one may call them so), I nevertheless thought it useful to take for planting in my nursery stones from an apricot grown in the Voronezh Province, without paying attention to the degree of hardiness of its parents—which were manifestly tender varieties. Thereby I would seem to have admitted that the direct and immediate parents do have a big influence, and to have ignored the influence on my seedlings of their more remote progenitors (i.e., grandfather and grandmother).

Actually, this is not so. Let me try to clear up the misunderstanding. Firstly, I do not deny absolutely that the direct and immediate parents have an influence; I only hold, on the basis of my personal observations and of irrefutable facts, that the individual properties of any particular individual, whether vegetable or animal, is transmitted in a greater degree to the grandchildren rather than to the children, as is usually erroneously believed. And for this reason, of course, it would have been incomparably more advantageous for my purpose if I had taken for planting stones, not obtained directly from the fruits of the first generation of the Voronezh apricot variety but from the fruits of its seedlings, i.e., of the second generation, even though these seedlings may have been grown in the same part of the Voronezh Province. It goes without saying that in that case the percentage of hardy seedlings I would already have obtained in the third generation would have been incomparably greater. But no such stones were available, and, willy-nilly, I had to content myself with the second-best.

Secondly, I have repeatedly pointed out, both in magazine articles and in the catalogue of my nursery, basing myself on long years of practical experiment[1] in acclimatization and the results achieved, that success in the acclimatization of fruit trees and shrubs[2] is best attained only by the method of planting seeds and training the seedlings in a locality with different climatic and soil conditions from those to which the given plant is accustomed. Because every plant possesses the faculty of comparatively easily altering its constitution,[3] in adaptation to the conditions of the new environment, only in the early stage of its existence, and only if propagated sexually. This faculty appears in the very first days after the shoot has sprouted from the seed. Later, it gradually diminishes, and almost completely disappears when full maturity is reached, after which the overwhelming majority of plants cannot undergo substantial alteration without considerable harm to their existence. The faculty of alteration also largely depends on whether the seed was taken from an old, long-standing variety, or from a new variety recently developed from seed. The latter, of course, produces offspring with an immeas-

[1] I am putting all this as I understand it, without regard to whether my convictions fit in with the theoretical conclusions of science or not.

[2] I am speaking here exclusively of fruit trees and shrubs: apples, pears, plums, cherries, apricots, peaches, grape, etc.

[3] I recognize acclimatization only when a fairly marked alteration of the constitution of parts or of the whole plant is observed.

urably greater capacity for alteration than the former. Furthermore, success likewise depends on whether the seed was taken from a tree living in the conditions of growth to which the variety was accustomed in its birthplace, or from a tree which was in one way or another pushed out of these conditions.

Let us take, for example, a tree grown in its birthplace, but on a soil of unsuitable composition or of a different degree of humidity,[1] or, lastly, trained in a different locality, in climatic conditions to which the given variety is unaccustomed. Here, too, the seedlings grown from seeds taken from the fruits of such trees will possess a greater tendency to alteration than the former.

In the present case, I took my seeds from a new and young variety, one, moreover, that had been knocked out of its rut precisely in the direction I needed; that is, one that had undergone considerable alteration when grown in the Voronezh Province, a locality lying some three hundred versts to the north of the zone of cultivation of the apricot in the open.

The acclimatization of the apricot described in this article should be one more proof to the reader of the futility of attempting to acclimatize a plant by means of other than the sexual mode of propagation—by transplanting the plant itself, in the form of layers, or of parts taken from it in the shape of cuttings for planting or for grafting. This procedure has never yielded good results, except in cases when the transferred plant already in its birthplace possessed the property to withstand the climatic and other conditions of the new locality. But where does acclimatization come in here? It is ordinary translocation, ordinary propagation. In other cases, even if some small, and moreover only illusory, success is achieved, the plants obtained in this way are, in their new locality, for the most part not in a stage of development, but, on the contrary, in a stage of decline and moribundity, so that nothing good can be expected to come of them or of their progeny.

Next, many readers, meeting for the first time in my article the statement that apricot varieties growing wild in Siberia totally lack hardiness in our parts, will probably doubt the truth of my assertion; all the more that many writers have spoken of the Siberian apricot, *Prunus sibirica*, as a fully hardy plant and have even recommended it for use as stock, as being the most hardy. And, indeed, here we have a wild apricot that freely grows in the environs of Nerchinsk, where the temperature falls to 40°R. and more below zero, yet it is claimed that in the Tambov Province its seedlings are not as hardy as those of the cultivated varieties of our southern peaches and apricots!

Yet this is an incontrovertible truth. On a dozen or so occasions I obtained from Nerchinsk and other places in Siberia, and from Manchuria and Mongolia, stones of the *Prunus sibirica* and its varieties, planted them, secured excellent sprouts, but *in the very first winter they all without exception per-*

[1] I have observed that if the seeds taken for acclimatization ripen in exceptionally dry years, they produce a far greater percentage of hardy seedlings.

ished. I have so far not succeeded in elucidating the true cause of this. I applied for a solution to authorities in the horticultural world, and received various explanations, but all of them were very far from the real matter at issue, and were of no practical value. The reason why the Nerchinsk apricot perished may with some degree of probability be ascribed to the fact that in its homeland it grows on the slopes of chalk hills, and all hill plants, as we know, do not survive transference to lowlands. And in spite of all my devices to provide it with conditions answering as far as possible to those of its homeland, by adding chalk to the light sandy soil, by planting it on the slopes of an artificial embankment, and so on, I achieved absolutely nothing. Every winter its seedlings perished, the injury manifesting itself in the form of a ring of blackened bark and wood close to the surface of the ground. This was equally to be observed in the case of select two- and three-year-old seedlings of cultivated peach and apricot varieties. And only very recently did grafting on the crown of a damson at last result in flowers and fruits. The latter, by the way, are totally inedible in all varieties of *Prunus sibirica*, but when planted in the second generation they apparently manifest a tendency to alter for the better. As to another species of wild apricot, *Prunus dasycarpa*, which is also reputed to be a hardy plant, this does not turn out to be the case in practice—which, to tell the truth, is not surprising, as its native habitat is Central Asia and the South Caucasus.

The variety of apricot that grows under this name in North Germany, according to my observations, proves to be even less hardy than those enumerated above. I have observed injuries of the higher overground parts, i.e., of the branches and shoots, in the *Prunus sibirica* to a greater degree than in seedlings even of the peach. I have tried all sorts of means of eliminating injuries to the lower part, but without success. I have covered the ground with sand, banked up the tree with earth, wrapped it around with bast, encased it in felt, bullrush, and sugarcane, daubed it with lime, varnish and various paints, shaded it with the help of boards, protected it with a roof over the whole plant, left the soil from the middle of summer unloosened and protected from superfluous moisture. But all to no effect, and I would be endlessly grateful to anyone who would suggest to me a method of averting the loss of sometimes apparently valuable individuals. In particular, select three- and four-year-old peach seedlings perish from this ringlike injury on the very eve of their first bearing, to judge by the fruit buds which have appeared on them in the autumn. I especially appeal to men of science, believing that they ought to show mercy on our ignorance and lack of understanding of the mysteries of acclimatization of plants and give us the real explanation of them.

First published in 1906 in
Progressivnoye Sadovodstvo i Ogorodnichestvo,
Nos. 39 and 40

Table VI. Apricots Tovarishch

TOVARISHCH

Seedling of a Blagoveshchensk apricot. The seed sprouted in the spring of 1926. It first bore fruit in 1931, in its sixth year.

Fig. 182. Nine-year-old Tovarishch apricot tree

Shape of fruit: round, sometimes slightly flattened; suture well marked; the remains of the style are fairly pronounced in the form of a peak.

Colouring: yellow, with a golden hue; slightly dull surface, covered by a fine down. The skin is fairly thick, spongy, easily tears, and is free.

Size: length 25 mm., diameter 27 mm., weight 17 gr.

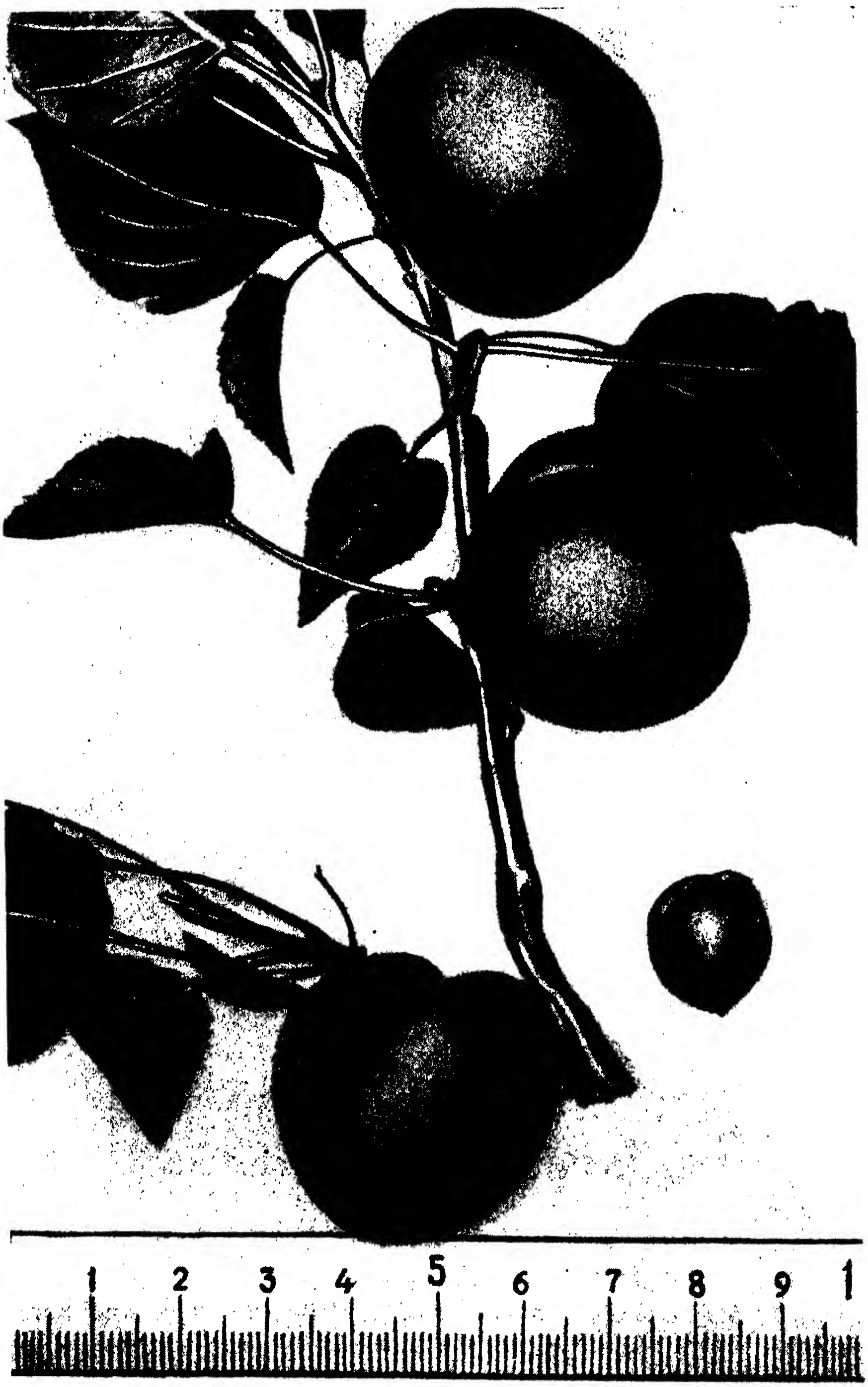


Fig. 183. Tovarishch apricots

Stem: thick, short, and set in a broad cavity of average depth. The stem is attached to the stone loosely.

Stone: round, small, with flattened sides, and sparsely pitted; the sharp ridge is more pronounced than the blunt, and has a steep rise at the spot where the stem joins the fruit.

Flesh: yellow, spongy, sweet, with a faint piquant bitter flavour.

Ripening time: second half of July.

Properties of the tree: very tall, with a flattened crown; the tree is undoubtedly frost-hardy and immune to disease.

It is one of the best apricot varieties, suitable for commercial cultivation by sovkhozes and kolkhozes in localities that are not very liable to early spring frosts, and one of the best for use as a parent in the development of new varieties of hardy apricots for the central and northern zones of the R.S.F.S.R.

1932

ALMOND

POSREDNIK

As far back as in 1885 I set myself the task of introducing the peach into cultivation in the central regions of Russia. At a first glance the problem seemed quite unsolvable, and chiefly because there is not a single cultivated variety of this southern species of fruit plant that can grow in the open in our region, with its relatively severe climatic conditions; and, what is more, even of the wild form—which is so essential in the production of local hardy varieties by means of hybridization—there is no representative growing in our forests except the dwarf, or wild almond (*Amygdalus nana L.*). Unfortunately, numerous attempts to cross the dwarf almond with the peach gave absolutely no reason to hope that such a combination was possible: these species are much too remote from each other in constitution.

The only thing to be done was to develop a new plant that would serve as a suitable intermediary link. Knowing that, in general, mutually remote pure species are far more difficult to cross than hybrids, and especially those of recent origin, I, in 1903, fertilized the flowers of a seedling of the tall-growing Mongolian variety of dwarf almond (*Amygdalus nana Mongolica*) with the David peach (*Prunus Davidiana Franch.*), which grows wild in the warmer states of North America.

Of the hybrids, a seedling selected for its more sturdy growth, complete hardiness, and a constitution most closely resembling that of the peach, was the first to bear blossoms. The flowers were very abundant, large, and of a pale-pink colour. The tree is over two metres high, and its resistance to severe frosts is exceptional: at a temperature of −38°C., not only do the shoots not suffer from the cold, but even the flower buds remain absolutely uninjured. The flowers are likewise exceptionally resistant to spring morning frosts. In

the spring of 1930 the almond was struck by 8°C. of morning frost. Posrednik was in full bloom at the time, but the frost had not the slightest effect either on the blossoms or on its bearing capacity in the following summer.

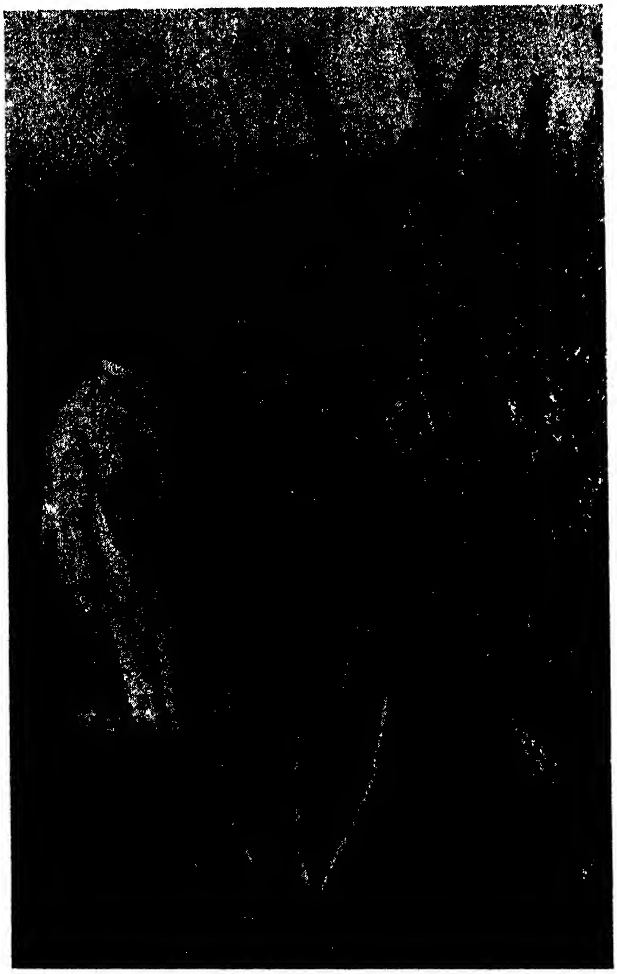


Fig. 184. Blossoming of Posrednik almonds

It bore fruit just as abundantly as in earlier years, when there were no frosts during its blossoming time.

In Northern Manchuria, where our old European varieties of fruit plants —Antonovka, Skrizhapel, etc.—are completely killed by the cold in the severe, snowless Manchurian winters, Posrednik feels perfectly at home and bears profusely every year.

The flesh of the Posrednik almond is rather dry, but its layer is incomparably thicker than that of our dwarf almond.

When Posrednik is fertilized with the pollen of large-fruited peaches, as many as 20% of its flowers set fruit, and the outward form and shape of these hybrid fruits remain the same as in those of the originals, except that the stones are more elongated.

Fig. 185. Posrednik almonds

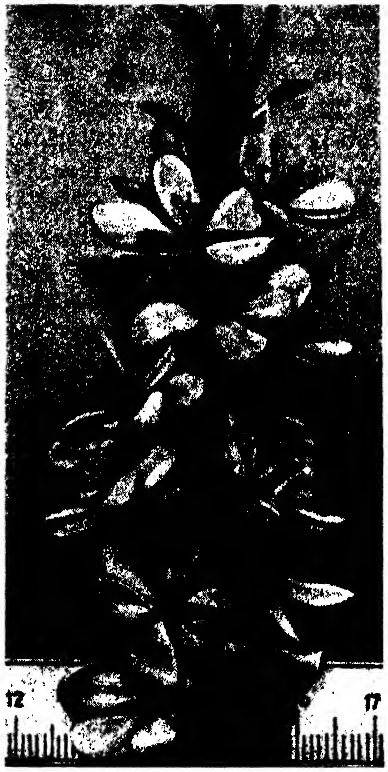


Fig. 186. An inflorescence of Posrednik

The almond hybrid is thus an intermediary link between the almond and the peach, which is the reason why it was named Posrednik (intermediary).

In the exceptionally cold winter of 1928/29, the mother tree of the Posrednik hybrid did not suffer at all, but a large number of hybrids of the Posrednik almond and the Iron Kanzler peach, which had until that winter grown absolutely in the open without any protection, perished.

Apart from its great scientific and practical value for the development of new frost-hardy species of peach for the central zone of the Soviet Union, Posrednik may be very useful for mass plantation for the production of pharmaceutical almond oil.

1932

SMALL-FRUIT CULTURES

IZOBILNAYA BLACKBERRY

I obtained this excellent blackberry variety by selection for hardiness from seedlings of a Lucretia blackberry, which was found in North America, in the state of West Virginia.

Izobilnaya is not exacting in regard to soil, and grows very well where many blackberries cannot properly develop, and if it is given tolerable attention it produces good crops in one and the same place for ten or fifteen years. Actually, care of the blackberry does not require much work and is very simple.

The soil under the bushes should be loosened two or three times in the course of the spring and summer, two-year shoots should be cut out, the bushes should be pinned down to the ground in the autumn and in the spring raised and tied to wire.

The root system of the Izobilnaya blackberry is compact and grows vertically downwards, spreading very little in width, and there is therefore no sense in planting the bushes far apart. As to soil treatment, although this variety is very unexacting and bears very well even on sterile soils, nevertheless it is recommendable thoroughly to turn over the site designated for planting to a depth of 40-50 cm., and only on lean soils should a dressing of well-decomposed manure be added. Good nourishing black-earth soils had better not be manured, otherwise the blackberry develops too luxuriant a growth, to the detriment of the fruit yield.

In the winter and summer the soil under the bushes must be kept free of weeds, and, as said above, loosened three or four times, and then covered with a thin layer of strawy manure. The blackberry begins to bear in the third year after planting, and already in the fourth year gives a full crop, and so abundant that every bush is literally covered with the berry clusters, each bush yielding about three kilograms.

In the spring the bushes are raised and tied to two wires stretched along the bed, one of them 25 cm., and the other 50 cm. from the ground.

Before the winter the shoots should be untied from the wire, pinned down to the ground and lightly covered with weeds, as a means of retaining the snow in winter time.

This blackberry can be successfully propagated by tip layering of young stolons. For this purpose, in the middle of August, the tips of young, one-year stolons are buried in the earth perpendicularly to a depth of 5 cm. Such layers develop roots in the same autumn.

They should be transplanted to their permanent sites only in the spring after the following, the plants being lifted together with the clod of earth encasing the roots.

1933

PRODUKTIVNAYA RASPBERRY

This variety was produced from a seedling of the Komertsia raspberry —a hybrid of the blackberry and raspberry.

The bush grows very tall, attaining to two metres, and like all raspberry varieties is greatly inclined to propagate by suckers. It prefers to grow only on elevated dry locations. This raspberry is not exacting as regards soil and grows equally well on rich black-earth and heavy clayey soil. In a dry elevated location it stands the most severe winters very well, but in low and damp locations it perishes, in spite of the fact that in both cases growth ceases only with the full onset of winter and heavy frosts. Ripe and unusually big berries may sometimes be found on shoot tips even at the end of November.

It is a generous yielder; besides the fruit branches, at the top of the stem and at the bottom near the roots sturdy lateral shoots appear which begin to bear somewhat later, but, on the other hand, the berries are considerably larger. Cropping continues for about two months; the yield is annual and abundant.

The berries are conical in shape, of a dark red colour, and with a sweet flavour.

The berries are firm, and if gathered with the core they never mash when cooked. They stand transportation very well, even on carts to a distance of fifty kilometres.

1934

TEXAS RASPBERRY

This variety was obtained by selection from seedlings of the American loganberry.

It is one of the best raspberries I have produced, and for size of berry and yield is unchallengeable. The fruit of the Texas raspberry is very large, attaining to 4 cm. in length and 10 gr. in weight. It yields abundantly and annually; on nourishing soils a bush will bear 6 kg. of large handsome berries.

The valuable feature about this raspberry is that the core does not come free of the berry, but remains within it, thus increasing transportability.

The Texas is propagated by tip layering. For this, in the spring, as soon as the shoots attain a length of 25 cm., the upper tips are nipped off. The nipping of young growing shoots must be repeated several times in the course of the summer, the effect being to produce a bush with many branching shoots, the ends of which, in the first half of August, after the two-year-old fruit-bearing shoots have been cut out, are bent down to the ground and buried to a depth of 5 cm. They should be buried perpendicularly, not obliquely.

The following spring, after the new shoot springing from such a layer has reached 10 cm. in length, it is transplanted, together with the clod of

earth encasing the roots, to its permanent location. The plants are spaced 2 m. apart in rows.

The plant requires a well-manured soil, the surface of which must be loosened and shaded under the bushes with a mulch of manure.

1933

ARABKA—A NEW VARIETY OF BLACK RASPBERRY

(*With Photographic Illustration*)

All the earlier varieties of the American black raspberry (*Rubus occidentalis*), e. g., Gregg, Ohio, Hilborn, Mills and the like, when grown in our parts yield, as we know, a rather juiceless berry, only fit for drying. It is possible that in their homeland, when cultivated on soils of a different composition, and in a climate less arid and continental than ours, the fruit of the black raspberry is not as dry; nevertheless, according to Y.O. Nemets, even there they are chiefly used for drying. Furthermore, both in America and here, the black raspberry has proved to be far less hardy than the red: it is more exacting as regards nutriment content of the soil, in consequence of which it yields a good harvest only for four seasons, not more, after which, even if the soil is manured, the berries diminish in size and the yield rapidly declines. In commercial cultivation, the bush has to be transplanted to a new site every four years. But we get quite a different picture when cultivating hybrids obtained by crossing it with our European varieties of red raspberry. In my nursery, for example, even when selecting from the first generation of hybrid seedlings, many individuals were obtained in which the above-mentioned shortcomings had completely disappeared: the berries had become so large and luscious as not to be inferior in this respect to the best European varieties of red raspberry, and even to surpass many of them, as may be seen from the excellent new hybrid of black raspberry described in this article, which I have named Arabka. As to frost-hardiness, some of these hybrids possess this quality to a phenomenal degree. For example, a hybrid of the Eureka black raspberry with the Marlboro raspberry, which I have named Damskaya because it has no thorns, even when its shoots have not been bent to the ground or have been given any other artificial protection for the winter, easily stands the 35°R. frosts of the Olonets Province. And even all the seedlings of this variety have proved to be quite hardy there, as has been described in detail in the article of Mr. Spirin, of Nikolsk, Vologda Province, in *Progressivnoye Sadovodstvo i Ogorodnichestvo*, No. 45, 1913. As to the reference in that article to the inferior hardiness displayed in the Olonets Province by the Texas blackberry-like raspberry produced by me, that is as it should be, since the Texas is only a simple, not hybrid, seedling —selected for its rather greater hardiness—of the loganberry, which here in the Tambov Province entirely lacks hardiness and cannot stand our winter frosts without solid protection. The homeland of this plant is in California, North America—a warm area located on the eastern coast of the Pacific, be-

Fig. 187. Arabka. Black raspberry hybrid. Produced by I. V. Michurin

cause of which its climate has a very even temperature and great humidity, which is the chief and inevitable reason for the tenderness of all plants growing in those parts. The selected seedling of the loganberry which I have named the Texas raspberry, proved in my nursery here in the Tambov Province to have a hardiness so much superior to that of the loganberry as to constitute a variety fully suitable for extensive commercial propagation in the Tambov, Voronezh, Kursk and more southerly provinces. But in the Olonets Province, where even the wild wood raspberry freezes to the snow line every year, the Texas raspberry is suitable for cultivation only in amateur orchards, and that in only the smallest numbers, and on the absolute condition that its shoots are protected against the winter with a two-vershok layer of earth.

The new hybrid variety of black raspberry described in this article, the Arabka, although it is twice as hardy as the Texas raspberry, will scarcely prove suitable for cultivation in such severe climatic conditions as those of the Olonets Province without artificial protection in the winter. But in our and in more southerly parts, Arabka will definitely reign supreme over all other varieties of black raspberry and, of course, will in time oust all other black-fruited raspberries from the orchards.

While developing an extremely sturdy growth, attaining to more than three arshins in height, and with a diameter at the base of the shoots of up to one inch, this variety produces no suckers at all, and consequently never gives rise to unpleasant growth. In spite of this powerful development of all the overground parts of the plant, and, most notably, its generous yield, Arabka is very unexacting as to soil composition.

At any rate, in my nursery, a row of these raspberries have been growing in one place on lean loam for already six years, without their growth and their abundant yield of big berries being diminished in the least.

The shiny polished shoots of new growth are coloured a bright green during the summer, but towards the autumn they turn a dark purple and become covered with a thick silvery-white bloom. The thorns on the shoots are large, but spaced fairly sparsely. Towards the beginning of August the tips of the shoots begin to pale and slightly thicken, a sure sign that the time has come for propagation by bending them down and burying them in the earth to a depth of one or two vershoks, where they very soon, before the autumn, take good root. Before the winter such layers, in order to protect them from the harmful influence of frost on their tender young roots, should be thoroughly covered with a good layer of dry leaves, and only in the spring, not before they have developed a young shoot two vershoks in length, should the latter be transplanted together with a clod of earth around the roots measuring a cubic quarter arshin. The shoot from which the layer has been cut should be raised, shortened to two arshins, and tied to a prop placed near the bush.

This is the best method of propagating this raspberry.

The very large and juicy berries of the Arabka are quite black, have a sweet, slightly acid flavour and a unique aroma, and make into excellent

jam, which is highly prized by connoisseurs. Here in the local market Arabka raspberries are eagerly bought at three times the price of other varieties of raspberry.

First published in 1914 in
Sadovod, No. 2

NEW CURRANT VARIETIES FROM CRANDALL SEEDLINGS

About twenty years ago a new variety of currant called Crandall appeared in foreign orchards. It was described here in our magazine *Plodovodstvo* (1890, p. 131), on American authority, as a hybrid between the common European black currant and *Ribes aureum*; this at least is the way its producer, Crandall, of Newton, Kansas, himself recommended the new variety. But on the basis of my experiments in planting the seeds of this variety and rearing its seedlings, I consider this opinion erroneous, if only for the fact that, of several hundreds of Crandall seedlings of two successive generations that I raised, there has not been a single specimen in which any of the earmarks of the common black currant could be observed; on the contrary, all the seedlings without exception had the typical appearance of *Ribes aureum*. From this I make bold to presume that the Crandall currant is simply a variety of *Ribes aureum*, and not a hybrid.

I do not know the opinion of other hybridizers, but in my own personal experience, planting of seeds of any hybrid variety, with very rare exceptions,[1] gives rise to seedlings which constantly manifest the phenomenon of segregation, i.e., some of the seedlings clearly display in their external habit the characters of one of the parents taken for the cross, while the others incline in their constitution towards the other parent. In the given case this phenomenon is not to be observed, and we therefore have weighty reasons for doubting the hybrid origin of the Crandall currant.

I take it that in advancing this explanation of its origin we are not in any way detracting from the virtues of this small-fruit variety. For its amazing fecundity, it has no rival. And, fortunately for us, its generous yield is fully transmitted to the majority of the seedlings, otherwise we inhabitants of Central Russia would be deprived of the opportunity of having so very profitable a variety for commercial cultivation, since the original Crandall currant itself has proved incapable of withstanding the frosts of our region.

Back in 1895 I ordered from Späth in Berlin three specimens of the Crandall currant, being desirous of introducing it into cultivation in our parts. But, I repeat, it proved to lack the proper hardiness here, and in the following winters the shoots were injured by the frosts to such an extent that no

[1] The rare exceptions are only those hybrid varieties which produce seedlings that represent a complete intermingling of the parents, and so much so that it is impossible to find any one part in them that resembles a similar part of one of the parents.

Fig. 188. Four new varieties of black currant from second generation Crandall seedlings. Produced by I. V. Michurin

berries were obtained at all. And only when, in the winter of 1900, they were given substantial protection did I secure an adequate crop of berries. They were about the size of a big cherry, of a black colour and bulbous form, with pronounced ridges along the axis of the fruit. The flavour was rather good, acid-sweet, and the seeds of relatively small size. The seeds raised from this crop of berries all, without exception, had the typical appearance of *Ribes aureum*, without any admixture of the characters of the common black currant. Part of them proved fully resistant to our frosts, and in the third year a big crop was obtained. But both the shape of the berries and their colour were considerably altered: the ridges had completely disappeared, the colour was of three different kinds—black, red and bright yellow—and the size had also diminished, although inconsiderably. The second planting of seeds, this time from berries of my own seedlings selected for hardiness, yielded splendid and undoubtedly constant offspring. Practically all the seedlings of the second generation, with insignificant exceptions, are completely immune to injury from frost, and are distinguished by amazing fertility. They bear very large berries, a photograph of which I attach showing, in natural size, four different varieties, differentiated by colour and shape. I have also sent the editors under separate mail specimens of the berries themselves of these new currant varieties.

In respect to the flavour of the berries of the varieties I am describing, I find that it is far superior to that of the Crandall currant. In particular, they make a jam with an excellent piquant flavour and fragrance, far surpassing in quality jams made from all other currant varieties. Bearing in mind the exceptional fertility of this new currant, I think there is every warrant to recommend devotees of the cultivation of small-fruit shrubs to test the variety I have described, and I shall have great pleasure in mailing free of charge a packet containing ten seeds to any subscriber to *Progressivnoye Sadovodstvo i Ogorodnichestvo*.

I deem it necessary also to point out the shortcomings of this currant, the chief of which is that it is very difficult to propagate by cuttings. In my experimental plantings in open beds, only ten out of every hundred cuttings took root. The reason for this, according to my observation, is evidently that the plants were recently developed direct from seed. As is always the case, never having been propagated vegetatively before, the plants have not yet adapted themselves to rooting easily from cuttings. It goes without saying that in the future this defect will completely disappear. Meanwhile, I recommend raising this currant from seeds, which germinate extremely well, while the seedlings are absolutely unfastidious, grow rapidly, and bear their first crop in the third year.

When planting, my usual procedure is as follows: I keep the seeds in a dry place until the end of September, and then plant them in a loamy soil in flat boxes, bearing in mind that owing to the smallness of the seeds they must be buried only to a depth equal to the thickness of a matchstick; after an adequate watering through a fine rose and providing the boxes with protection from birds, I set them out in the open, where they are left all

through the winter. In the spring, when the shoots have developed the fourth leaf, they should be pricked out into the beds and spaced at intervals of one-quarter arshin. In the following spring they are transplanted, for the last time, to their permanent location, the bushes in the rows being spaced one and a half arshins apart, with three arshins between the rows. This currant likes a rich, friable soil of average humidity. It is well to dig over the beds preliminarily to a depth of three-quarters of an arshin. Covering the soil under the shrubs with fresh manure also helps the development of the plants.

The second and last shortcoming, in my opinion, is that the berries in each cluster do not ripen at the same time. The upper berries in the cluster may be completely ripe, yet the lower berries are still green. There is only one way of eliminating this defect, which is to select for reproduction only such seedlings as bear clusters the berries of which show a greater tendency to ripen simultaneously.

But these two shortcomings are not of great significance and do not detract from the virtues of these new varieties very considerably, especially when it is borne in mind that every plot of ground located in close proximity to trading centres that is used for the cultivation of these varieties is capable of yielding returns comparable only with those obtained from the most profitable other cultivated plants, not to speak of all earlier varieties of currant and gooseberry, which, in respect to profitability, they leave far behind.

The attached photograph depicts four different strains of the new currant: A—black, very large-fruited; B—red, very large-fruited; C—amber-yellow, large-fruited, round; D—yellow, oval-shaped.

First published in 1908 in
*Progressivnoye Sadovodstvo
i Ogorodnichestvo*, No. 36

GRAPE

NEW HARDY VARIETIES OF EXTRA-EARLY GRAPE SUITABLE FOR CULTIVATION IN THE CENTRAL ZONE OF RUSSIA AND IN SOME PARTS OF SIBERIA

Already in 1883, when attempting to cultivate the grape in the open in the Tambov Province, I was forced to the conviction that it was utterly impossible to do this with profit in our parts. In spite of the fact that I had acquired vines of the best hardy and early-ripening varieties, that they were planted in protected places against walls facing south, that the vines were carefully banked up with earth against the winter, and that pruning for fruiting was performed accurately, the results of my labour were extremely unconsoling. The fruits of the majority of the varieties failed to ripen in

time and, with few exceptions, were caught by the early autumn frosts which often visit us already in the second half of August. Further, although some of the varieties, e.g., Madeleine Angevine, Malingre précoce and the like, did in favourable years manage to ripen by the end of August, the flavour of their fruits and the appearance of the clusters were so unsatisfactory as to be positively unable to compete in the market, which by then was already loaded with grape varieties brought in from the South. Purchasers willing to buy an inferior grape at a higher price were, of course, not to be found. And to sell it cheaper than the imported grapes was quite impossible, bearing in mind the expense of tending the plants. In a word, grape cultivation in the Tambov Province was a mere whim, a desire to have one's own grape, even though it were twice as costly as, and inferior in quality to, imported grapes. I tested masses of varieties, but all the so-called early and relatively hardier ones I could lay my hands on, both of the European and the American species, proved to be absolutely unsuitable.

Firstly, none of them was hardy enough to grow freely and to mature in the open without laborious and costly artificial protection, involving glass frames in the spring and autumn, and solid banks of earth in the winter. Secondly, the ripening time of the grapes of even the earliest varieties very rarely, only in favourable years, happened in the second half of August; it was usually in the second half of September and even later; and this season in our parts is already fairly cold, and for this reason, apparently, the fruits did not get the sum-total of heat they need for the formation of grape sugar, as a consequence of which the fruits turned out to be sour.

In general, it has to be recognized that the central zone of Russia is so far removed from the northern boundary of the commercial cultivation of the grape, that not one of the known varieties is of use to us, and that, consequently, we have to have special varieties, with properties adapted to the climatic conditions of our region. Such varieties must possess two main qualities. Firstly, the vines must be content with the shortest possible vegetative period for the development of their wood, and must also possess a degree of frost resistance that would preclude the necessity of laborious and costly winter protective devices. Secondly, the ripening time of the grapes must be of the earliest, for example, in the second half of July, and in any case not later than the first half of August. At this season the solar heat in our parts is adequate, and the grapes will therefore not be sour.[1] Ripening so early, such a variety, even if its qualities are mediocre, will find a lively sale in the market, because of the complete absence of competition from imported varieties, which usually flood our markets in the second half of August. There was only one way of developing new varieties with such qualities, namely, by planting seeds and rearing the seedlings under the influence of the local climatic conditions, and then, by means of selection, picking

[1] Of course, acidity also depends on the variety of grape, and not exclusively on climatic conditions, but such varieties should not be chosen.

out the individuals with the desired virtues. With this object in view, I sowed chiefly the most hardy and for the most part early-ripening varieties of grape. But the first experiments were unsuccessful and did not yield good results. More than ten years of labour had been wasted in vain. For instance, all the seedlings of the European species proved to be of low hardiness, while the American species, although they produced an adequate quantity of frost-hardy individuals, yet some of them blossomed but did not set fruit,[1] others ripened too late, while others still bore small, sour and absolutely worthless fruit. Fortunately, about this time (1896-97) my good friend Yaroslav Ossipovich Nemets sent me seeds of various varieties of grape which he had obtained from North America, among them Gibb, Brand, St. Hillaire, St. Mariana and others belonging to the species *V. vulpina* or, which is the same thing, *V. riparia*, and Concord, Moore Early and others of the species *V. labrusca*. In all, there were about twenty varieties, but I have enumerated only those from which I obtained seedlings that were not killed by frost and have survived to this day. The plantings from this second party of seeds were far more successful.

Quite a considerable number of seedlings proved to be very resistant to cold and, in spite of the fact that I have never protected them in winter in any way, except by bending the vines to the ground, they are still thriving. At first, this quality was most marked in the four enumerated Canadian varieties. Yet the frosts in those years attained to -29°R., and time and again vines that the snow had not covered withstood temperatures lower than -20°R. I did not practice rational pruning of the vines, confining myself generally to simply removing superfluous and shortening excessively lengthy canes.

The soil was sandy, dry and unmanured. In a word, the regimen was of the sternest. Of these seedlings, last summer (1906) ten varieties bore their first fruits. Of my three seedling vines of the Brand grape, one bore masses of clusters, which ripened at the end of July[2] and proved to be of good flavour. Because of the colour of the grapes, I have called this new variety Severny Bely (Northern White). Of the remaining seven specimens, one Gibb seedling vine produced small but very compact clusters of fairly big grapes of a purplish dark-blue colour, which ripened at the beginning of August. This I have named Severny Chorny (Northern Black). The other two Gibb seedlings produced the very small clusters and tiny grapes typical of the *V. riparia* species, and are unsuitable for use. Of the four St. Hillaire seedlings, only one yielded fine clusters of grapes of a dark colour and with a good flavour, but ripening later. I shall describe this variety after I have elucidated certain qualities in the 1907 bearing, and in the present article shall confine myself to the description of only two varieties.

[1] The cause was some deformity of the morphological organs—complete absence of pistils or feebly developed stigmas, etc.

[2] It should be borne in mind that the spring of 1906 was a very early one, so that in other years ripening time may differ by about five days.

ACTINIDIA

NEW VARIETIES OF ACTINIDIA

The large-fruit variety of *Actinidia arguta* has been growing in my nursery for over twenty-five years, but, by comparison with that other Actinidia variety, *kolomikta,* it has proved to be insufficiently frost-hardy, particularly in its early years, and, in addition, of extremely low fertility.

We have now acquired three types of this valuable Actinidia variety, that are quite frost-hardy and yield abundant crops. They originate from the Kabany Klyuch, a locality in the East Siberian taiga. In this area Actinidia has for many decades withstood frosts of as much as 40 to 45°C. below zero, which in some years set in before the ground was covered with snow.

ACTINIDIA UROZHAINAYA

This variety of *Actinidia arguta* seedling was found in the taiga, in the upper reaches of the Kabany Klyuch, Nikolsk-Ussuriisk District, at a height of 325 metres. Despite the fact that the plant was a young one, being from

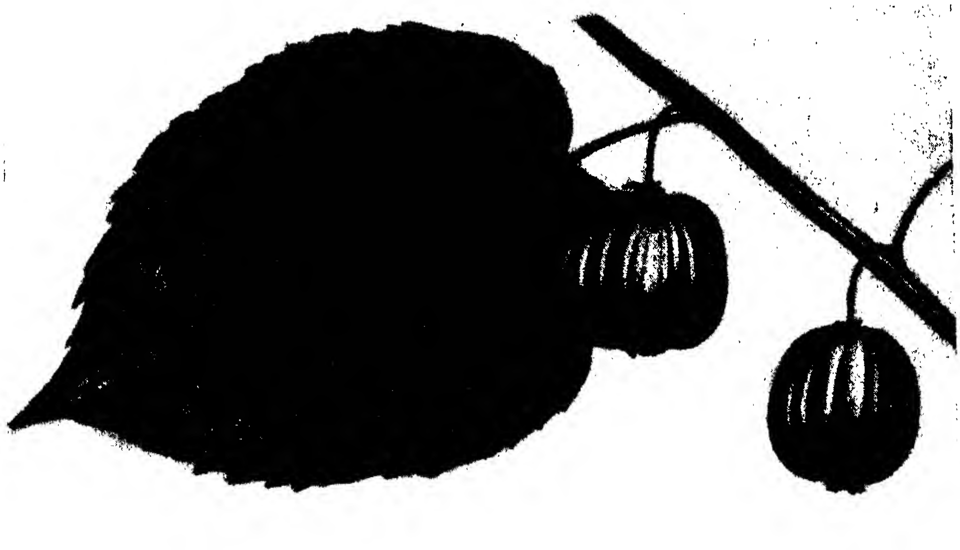


Fig. 189. *Actinidia arguta* No. 1—Urozhainaya

ten to twelve years old, it produced a very abundant and regular annual crop. The berries have a lusciously sweet flavour. The plant is distinguished for its fresh, healthy appearance and is not attacked by pests. The most valuable property of this variety is its early first fruiting.

The berries begin to ripen in the middle of August.

ACTINIDIA RANNAYA

This Actinidia also originates from seedlings of the *Actinidia arguta* which was, however, found at another spot—the watershed between the Kabany Klyuch and the Molokanka, at a height of 350 metres. The plant is not a

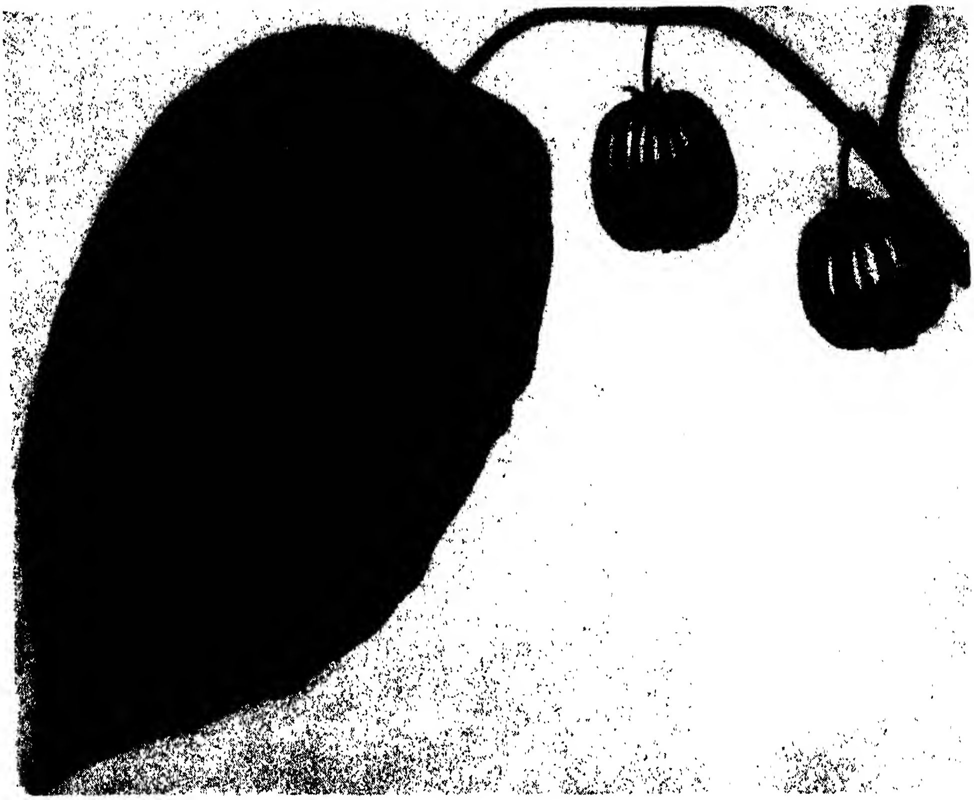


Fig. 190. *Actinidia arguta* No. 2—Rannaya

tall one, though it is forty years old. It is perfectly healthy, and no disposition to pest infection has been noted.

The fruit yield is an abundant one, and the berries have a pleasant flavour; they ripen in the middle of August.

ACTINIDIA POZDNAYA

This variety comes from the same area as the two previous Actinidias. It was found in the Kabany Klyuch valley at a height of two hundred metres. The plant is nearly thirty years old, but the foliage is fresh and not damaged in any way.

It yields a particularly abundant crop. The berries have a pleasant flavour but ripen at a later period, at the end of September.

Fig. 191. *Actinidia arguta* No. 3—Pozdnaya

MICHURIN ACTINIDIA ANANASNAYA

This fine variety of Actinidia is the result of selection from the third generation of *Actinidia kolomikta Max*. The planting took place in 1924 and the germination was observed in 1925.

The first bearing took place in 1931, the seventh year of its growth.

Shape of fruit: varies considerably. On one and the same shrub you can find broad, oval-shaped ones, elongated ones, and irregularly broad and blunt cone-shaped ones, etc. Some of the berries possess deep side seams that stretch from the stalk to the bottom of the calyx. Sometimes these seams cover the entire berry from top to bottom. Sometimes they only cover half of the berry. The surface of the berry is slightly ribbed.

Colouring: dark green, uniform; in the rib hollows it develops into a light green.

Size: length 17 mm., diameter 19 mm., weight 3.1 gr.

Pedicle: 21 mm. long, thin, brown coloured; situated in a narrow irregular cavity, the depth of which varies considerably from shallow to deep. It is weakly attached to the berry, but quite strongly to the vine. The sepals protrude as dried, brown-coloured remnants.

Calyx: protruding from the calyx are the dried brown remnants of styles which are situated in an irregular, shallow depression, which in its turn sometimes assumes the shape of a long shallow fissure.

Flesh: as compared with other varieties of Actinidia the flesh of this new one is more compact, thus considerably increasing its shipping qualities; many other varieties cannot be shipped at all (in view of the exceptionally tender and melting character of the flesh).

The flesh of the Michurin Actinidia Ananasnaya is of light-green colour, juicy, sweet with a light refreshing piquant acidity, and has a wonderfully fine aroma similar to that of the pineapple.

Seeds: very small, so that when consuming the berries one does not notice them at all. Their colour is dark brown.

Ripening time: in 1933, when the spring dragged out and the summer was cold and wet, they were ripe for consumption by August 20.

In the central zone of the U.S.S.R., when the vegetative period is an ordinary, normal one, the ripening time is in the early part of August.

Properties of tree: the liana, in its ninth year, reaches a height of four metres. Two-year-old shoots are smooth, brown coloured, and are often covered with rather dirty-brown spots. One-year-old shoots are brown coloured with light-brown dots. The leaves are thin, oval-shaped and pointed, while some of them are cordate, doubly and sharply serrated, with very fine and frequent rusty-coloured hairs along the veins of the underpart of the leaf. The surface of the upper part of the leaf is covered with white-coloured hairs set more widely apart. The flowers droop and grow singly.

The Actinidia is a diclinous plant, but the blossoms on the female bushes are bisexual. In the shade the leaves of the male specimens are green, and in the sun become dull white or variegated white rose. This variegation of the leaves, however, occurs not only with the male, but also frequently with the female, specimens.

At the end of May and in the early part of June the lower part of the leaf gradually begins to pale, until it becomes perfectly white. Following the albinism of the leaf a delicate light-pink colouring begins to appear and spread over its lower part, the top part of the leaf remaining green. The combination in the leaf of three colours—green, white and pink—is an exceedingly impressive sight, so that the Actinidia can serve as a splendid decoration for parks and public squares. Its blossoms are white and mostly fragrant.

The vines of the Michurin Actinidia Ananasnaya excellently withstand

Table VII. Michurin Actinidia Ananasnaya

the winter of the central zone of the U.S.S.R.; for that reason the cultivation of this Actinidia can be advanced far North.

The Actinidia is easily propagated with cuttings, as are currant or grape. The cuttings have to be stored in the autumn after the leaves have fallen. On no account is it recommended to make Actinidia cuttings in the spring, since the powerful spring sap movement causes "tears" to flow from the vines from which cuttings have been taken. This leads to the shrub becoming very much exhausted.

The Actinidia can successfully be propagated with green cuttings in July, the cuttings being planted in cold frames.

The defect of the Michurin Actinidia Ananasnaya berries, as indeed of the entire *Actinidia kolomikta* species, is that they ripen on the bush at different times, and easily drop.

This new type of Actinidia, the Michurin Ananasnaya, stands out among other small-fruit plants. Its berries can be used not only for dessert and high-grade confectionery; they can also be used for the production of high-quality essence of which our food industry now stands in such great need. The variety deserves particular attention and should be extensively propagated in our socialist economy.

ACTINIDIA CLARA ZETKIN

This splendid large-fruited variety of Actinidia is the result of uninterrupted selection from the fourth generation of the *Actinidia kolomikta*.

The seed germinated in 1926. The first bearing took place in 1932, the seventh year of the seedling's growth.

As distinct from all the other new varieties of the Actinidia, the Clara Zetkin variety possesses the valuable quality of its berries dropping to an inconsiderable degree during the ripening period. This is due to the fact that the pedicle adheres quite strongly both to the berry and to the shoots.

Shape of fruit: from rather elongated to elliptical—sometimes asymmetrical.

Colouring: light green with white-green longitudinal stripes; the colour is uniform over the entire surface.

Size: length 34 mm., diameter 14 mm., weight 3.8 gr.

Pedicle: 17 mm. long, thin, brown coloured with dried dark-brown sepals. There is no cavity, and the pedicles of some berries are placed on small protuberances.

Calyx: small, with an inconsiderable number of half-dried brown styles. Is situated in a very small regular hollow.

Flesh: pale green, juicy, very sweet, and possessing a strong specific aroma. If the berries are overripe the flesh becomes transparent, so that all the seeds inside the berry become very marked, and stand out as small dark dots.

Seeds: small, brown, rather rotund.

Ripening time: on and after August 20.

Properties of tree: at eight years of age, on dry sandy clayey soil, and on an open site, the liana grows to a height of three metres; the Clara Zetkin is absolutely hardy to our severe winter frosts, and its vines are not in the least affected by the frosts in our localities which reach as low as 35 to 40°C. It is distinguished for its total immunity to parasites of both the animal and plant worlds.

The size of its fruits and their fine flavour earn this variety the right to be widely distributed.

MISCELLANEOUS

SEEDS, THEIR LIFE AND PRESERVATION UNTIL PLANTING

I presume that many fruit and vegetable growers will be extremely interested in clearing up a question of prime importance to their vocation: what causes plant seeds to become damaged, and, sometimes, even to perish, while being preserved for planting, or after planting? It is high time for fruit growers to take the trouble to elucidate as fully as possible and, what is more important, from various points of view, the rather complicated causes of frequent cases of seed spoilage. It is quite difficult to solve this question. Here the experiments and observations of some one person, however outstandingly competent he may be in the domain of fruit growing, will not be enough, will be too one-sided. What is required here is joint work, the conclusions drawn from the results of many years' observations of several persons. I stress the words "many years" because the solution of the serious problems of fruit and vegetable growing in general, and of the given matter in particular, requires the opinions of exclusively such people as have conducted observations over long years of their own work in cultivating various fruit plants, and having had the opportunity to repeat the same experiments several times over, have been able to verify their conclusions. We do not need discourses of various kinds by novices in the field. Not infrequently they only confuse and obscure the solution of a problem, and their premature conclusions in the majority of cases do nothing but harm. And yet on the pages of journals devoted to fruit and vegetable growing one frequently encounters such articles, and sometimes whole brochures by way of supplements, the authors of which left the school bench only five or six years previously. It goes without saying that these first years of every young fruit grower nearly always abound in errors and failures both in the work itself and in the conclusions drawn from their brief and mostly superficial observations, of the erroneous character of which they have not been able to convince themselves because the time has been too short and their work too brief. Such people have still to learn themselves, and yet they take pen

in hand and scribble articles in which they set out with aplomb to discourse on the most serious problems of fruit growing.

That is why for the collective elucidation of the problem posed in this article I appeal exclusively to people with extensive experience, to persons who have become grey in the course of many years of labour in practical fruit or vegetable growing. And, of course, various diplomas testifying to special theoretical education can be of little importance in the present instance if only for the fact that in our institutions of learning too little attention is paid to the subject, and, consequently, when students leave school they carry away with them an incomplete knowledge of the factors that exert harmful or useful influence on the qualities or even on the vitality itself of plant seeds in the various stages of their existence from their ripening until their germination.

For my part, I shall attempt here to make known only those interesting facts which I have personally observed repeatedly in the course of my nearly forty years of fruit growing. Incidentally I shall cite some data from the foreign press about tests conducted there on the hardiness of seeds in specially low temperatures.

First of all let us consider the nature of the seeds of various plants. Physiology teaches us that each seed is in its way a living organism: the body of the seed consists of numerous cells, part of which comprise the germ, while most of the other cells contain a supply of substances necessary for the vital processes of the germ protoplasm until the plant sprouts from the seed and for the shoot's nutriment until the young roots develop sufficient activity. It can be seen from this that the vital process does not stop in the organism of any seed, even when the seed is still in a state of dormancy, i.e., in a dry state, metabolism though slow is constant, sustaining the life of the germ cell. The proper course of this metabolism depends entirely on the environmental conditions in which the seed finds itself until it germinates. The metabolic process may gather speed or slow down, and, finally, may almost cease completely for a certain period the duration of which differs not only for each species and variety of plant but even for each separate seed.

The seeds of some plant varieties may, under conditions favourable for their preservation, retain their vitality for several decades, while the seeds of other plants barely remain alive a few hours. A great deal has been said of the almost unbelievable vitality of seeds. Many people probably know of the legend about wheat grains that came to life after having been dormant for a thousand years in an Egyptian pyramid. As a result the belief in the stability of the vital source in seeds of plants was greatly strengthened. To what extent this tale is true I shall not undertake to judge, but I well remember that in my early childhood my father and I were planting seeds from a package, and he said that those were seeds from wheat that had been grown from a grain found near an Egyptian mummy; that, of course, particularly intrigued me at the time and served to preserve the legend in my mind to this day. (I believe the seeds in those days were distributed by the Free Economic Society.)

To this day many people are ready to believe such fables, this being possible, in their opinion, because the activity of the protoplasm of the germ cells in some plants, including that of wheat, may pass into a state of complete dormancy, and the metabolism in the seed may cease completely for an indefinitely long period. Consequently, they assert, no losses in the grain will take place during this period, and in such cases the seed does not, so to say, grow old. But such suppositions and fables about seeds germinating after having lain for thousands of years in the ancient tombs of Gaul or in the catacombs of Egyptian pyramids, should positively not be believed. The absolute *cessation of all vital functions of a seed even for a relatively brief period of time must inevitably result in the complete destruction of the seed.* Even when it is in a state of dormancy a grain's vital functions do not cease completely, but are merely reduced to an extreme minimum.

In metabolism their store *is constantly, though slowly, expended throughout the whole life of the grain,* the duration of which, I repeat, differs not only in seeds of different species and varieties of plants but even in each separate seed, because in one and the same fruit the store of vital forces almost always differs from seed to seed. This last can be seen clearly from the fact that their germinating power gradually drops in proportion to the length of time seeds are kept before they germinate. This fact also undoubtedly serves as irrefutable proof that the vital functions of the grain do not cease during its relative dormancy. Expenditure and exhaustion are inevitable, and seeds that have a quantitatively greater store of vital forces are able to live longer than seeds that have a smaller store. Of course, in the fact cited concerning the varying duration of the life of seeds, an important role—apart from quantity—may also be played by the qualities of the substances contained in each seed which serve as material for the life of the germ cell, but we shall not analyze this now if for no other reason than that it is as yet beyond our power to determine the qualities of the nutritional substances in the seed. In the present case all we can state that will be of benefit to our work is that it is possible for man to take reasonable measures to prevent the materials deposited by Nature in the grain from spoiling, by ascertaining in advance the various causes making for one or another kind of damage to the qualities of seeds while they are being stored.

First of all let us take note of the fact that not all damage to seeds is detrimental to us. It appears that there is such damage that is useful to us in the cultivation of certain plants and we evoke it deliberately. For example, we purposely overdry cucumber and melon seeds and use for planting only the older ones that have been preserved four or five years, because the plants grown from such seeds provide a greater yield.

But this method is advantageous only in the case of cucumbers, melons and certain varieties of squash. In most other cases the seeds of the very latest harvest are preferable because both overdrying and long storage of seeds inevitably have a harmful effect on their qualities, the proportion of germination dropping to a considerable extent, while the plants grown from the surviving seeds do not develop as well as those grown

from seeds freshly picked. This is especially evident when rearing fruit-plant hybrids. Here not only is it impermissible to keep the seeds for several years before planting, but often even to dry seeds in the ordinary way for a few extra days vastly lowers the quality of the seedlings grown from them. This is easily noticeable, to an experienced eye, of course, from the habit of even one-year-old seedlings of hybrid fruit trees of cultivated varieties.

The first time I came across and noticed this phenomenon was when planting the seeds of an Aport obtained in 1890 from fertilizing the blossoms of an Aport with pollen of a Kitaika (*Pyrus prunifolia*). Part of these seeds were planted in one row in a bed of loamy soil in autumn directly after being taken from fruits picked from the trees, while the other seeds were removed from the fruits only in winter, at the end of December, and kept in a heated living room until planted in spring. When the snow melted, these seeds, after moistening, were planted in a second row in the same bed. Both rows of seeds sprouted with very little difference as to time, but with a rather noticeable proportion of losses in the second row, that had been planted in spring. Compared with those planted in autumn there was a 10% loss of seeds which failed to grow.

Then, while cultivating the seedlings from the very first year and throughout the subsequent period until the first transplantation from the bed to their permanent sites the two rows of seedlings sharply differed from one another with respect to the luxuriant development of all parts. After transplantation, which took place at the end of the third year of the seedlings' growth, the difference somehow smoothed out, but with the beginning of fruit bearing the difference between the trees was reflected in the following: although the trees of the second, i.e., spring, planting started their first fruit bearing earlier than did the trees of the first, i.e., autumn, planting, the quality of their fruits as regards size and flavour was far lower. Unfortunately none of these trees showed any outstanding results, and so they were destroyed. But I have at the present time in my nursery six hybrid pear trees obtained from fertilizing the blossoms of a Ussurian pear tree with the pollen of a Beurré Diel. An experiment similar to the one referred to was conducted with the seeds of these hybrids.

In the autumn of 1901 about a dozen seeds—not fully ripe and still rather whitish, it should be noted—were taken from three hybrid fruits of a Ussurian pear tree that had been fertilized by pollen taken from a basket specimen of a Beurré Diel pear tree, and were planted in a box in the open air. The other four fruits were kept until January and the seeds taken from them were planted in the same box only in spring. After sprouting, the seedlings were lined out in beds. No sharp difference was noted either as regards the loss of shoots or the development of seedlings from the two plantings, but later when the trees bore fruit the difference did not fail to manifest itself in a somewhat original manner, namely, the trees of the second, spring, planting in which the dried seeds had been used, started fruit bearing in 1910, and also in 1911 and 1912, whereas the trees of the first, i.e., autumn,

planting in which fresh, undried seeds had been used began fruit bearing only in 1913, but the quality of the fruits of the trees that grew from the dry seeds was incomparably worse. In the first place, they all proved to be early-summer ripening fruits, unfit to store for winter, and as regards taste they were very viscous, a characteristic of the Ussurian pear, although in size they were four times as large as the fruits of the maternal tree. Then altogether inexplicable was the fact that all these trees of the second, spring, planting were less hardy to our climate and especially to the scorching of the stem's bark by the sun. In contrast, three trees of the first, autumn, planting, when fresh seeds were used, yielded, firstly, late-ripening fruit capable of keeping in winter storage until the end of December, a great advantage for new varieties in orchards of our localities in Central Russia, and, secondly, the fruits have an excellent flavour and a flesh that is without granulation and melts in one's mouth. Moreover, the trees themselves are noteworthy for complete hardiness to the climate of our locality, and of all our pear-tree varieties they are the only ones the bark of which does not suffer from sun-scorch.

The greater hardiness of these trees was perhaps due also to the influence of the seeds freezing before germination, but, unfortunately, I was unable to test the correctness of this supposition, or, to be more exact, I could find no method for accurately testing this influence.

Exactly the same experiments were conducted with cherries and the results were also exactly the same. In general, many experiments were conducted along this line but to describe them would be a repetition of practically one and the same thing, and would only uselessly stretch this article. From the experiments cited here we can see clearly, firstly, that excessive drying of seeds of cultivated fruit plants, even if only for a few months, may in the future bring irreparable harm to plants grown from such seeds. Secondly, these experiments also show that in hybridization, when new fruit-plant varieties are bred from seeds, even overdrying, which may at first sight appear to be such an insignificant impairment, has an enormous influence on the hybrid seedling's inclination towards one of the parent plants. Thus, in the first example cited above the hybrid seedlings grown from overdried seeds almost wholly inclined towards the Kitaika, and in the second example cited, the hybrid seedlings of the pear tree also grown from seeds that had been dried during the winter, inclined towards the wild Ussurian pear tree, whereas the seedlings grown from the seeds that were planted in the autumn, directly after they had been taken out of the fruits, all without exception inclined towards the Beurré Diel, the cultivated parent variety.

The experiments I conducted along these lines, I reiterate once more, were repeated by me several times, and always with the same results.

I presume that the fact that the seeds' dryness alone was enough, as shown by me, to incline the hybrids towards the qualities of one of the parents, along with the many other facts of a negative character as regards the applicability of the Mendelian law to hybridization, will bring Mendel's follow-

ers somewhat to reason. Of late, our neophytes in the field of hybridization have tried particularly importunately to foist that pea law—the creation of the Austrian monk—upon us and, what hurts most is that they do not cease their efforts even though this law has been utterly condemned by our Professor M. V. Rytov, who is deserving of respect and whose personal experience certainly makes him highly competent in the realm of hybridization. In *Progressivnoye Sadovodstvo i Ogorodnichestvo,* issue No. 2 for 1914, he called Mendelism outright "a sorry and miserable creation." Is this not enough for you, gentlemen? Will you nevertheless keep on bothering with this pea law and ignore the word of such a Russian authority as Mr. Rytov? That will be absolutely unreasonable. Of course, such endeavours on the part of our admirers of every foreign nonsense can have no importance whatever for Mr. Rytov, nor will they mislead other people with practical experience of their own, but what colossal harm does such an attitude inflict on young Russian horticulturists who are only beginners, still inexperienced, and are not yet able properly to appraise the works of various authors because they know absolutely nothing about them. These people do not know that Professor Rytov, besides being an instructor in the Goretsky Agricultural School, has worked almost all his life in the field of fruit and vegetable growing and produced a mass of printed works dealing with these spheres of agriculture, whereas Mendel's experiments in hybridization concerned peas exclusively and represent only the notes of a Catholic monk, long since dead, notes that were dug up in the monastery's archives and recently made public by Tschermark, an Austrian professor, and by other foreign scientists. In the spring of 1913 an experimental station called "Mendeleum" was opened in Austria where the Mendelian laws are being studied.

The results of these studies will only be made known in the future, but it is doubtful if the information to be furnished will be truthful.

Judging from my observations I find that Mendel's conclusions are not applicable to the hybridization of fruit trees and berry bushes. As irrefutable proof of this I shall try shortly to describe experiments in crossing cultivated apple varieties with the Niedzwetzkyana apple, which possesses the peculiarity that its leaves, shoots and bark, blossoms and the entire flesh of the fruit have a bright red colour. This property of one of the parent plants has provided an opportunity, unprecedented in the hybridization of fruit trees, for tracing more accurately and in a relatively short time the hereditary transmission to the hybrids of the properties of both parent plants.

I beg pardon for the digression, and I now return to the main theme of the article, i.e., seeds and their preservation.

From my observations during nearly forty years of work in breeding from seeds new varieties of apple trees and berry bushes, I am fully convinced that seeds of apples, pears, cherries, plums, raspberries, blackberries, currants, strawberries, etc., always lose their good qualities depending upon the length of time they are kept before being planted, even though conditions

of storage are the most favourable, not excluding the best stratification[1] arrangements. In all cases where seeds cannot be planted shortly after they ripen, the best results are obtained by planting them in autumn with the advent of cold weather. Wherever possible this method should be given preference. Whenever it is impossible to plant in autumn, the best way to preserve the seeds is, of course, by stratification, which consists of the following: the seeds are mixed with or are deposited in layers between slightly moistened river sand previously well washed and tempered in a hot oven. This mixture is placed in a new unenameled earthenware vessel that has been well soaked in boiled water, such as large low pots with narrow necks, or, when the quantity of seeds is small, ordinary flower pots. A hole should be made in the bottom of such a vessel to allow for water that might accidentally get into it to drain. This hole should be covered by a piece of crock, which should be placed inside the pot with the convex side up. Then, after arranging the seeds in the pot in layers with sand in between, or simply mixing the seeds with sand and pouring it into the pot, the latter should be covered with a saucer, of the same kind of material of a somewhat larger diameter than that of the pot's neck, which should without fail be placed upside down. Such a cover fully protects the seeds from injury by mice and, at the same time, effectively prevents water from getting into it. It is best to bury such a vessel with seeds outdoors in the garden to a depth of not more than a quarter of an arshin above the pot, but it should positively be on a rather high spot where water cannot accumulate during winter thaws or spring floods. The amount of sand to be taken in such a case is no less than three times the quantity of the seeds. For large seeds as, for example, plums and nuts, somewhat more sand should be taken, and for small seeds proportionally less. The moistness of the sand should be uniform and not excessive. A wide and low vessel is preferable to a high and narrow one because seeds have to have free access of air, the oxygen of which is essential for the life of every seed. Seeds that are preserved dry, must not, therefore, be placed in hermetically-sealed vessels such as jars with ground-in stoppers. In such cases it is best to tie a not very compact piece of material around the glass dish containing the seeds. The amount of moisture contained in the air surrounding the seeds that are preserved dry also plays a big part. The very dry air of dwelling rooms, especially those heated by coal or ovens is as harmful to seeds as the air of damp cellars. Seeds keep best in premises that are not heated and not damp. If seeds have to be kept in dwelling rooms they should be kept away from stoves and damp corners. As regards the usual open-air temperature in our locality, whether in summer or in winter, dry seeds, i.e., those in a state of dormancy, will not be harmed by them, even at the limits of their fluctuation from $+40°$R. to $-40°$R.

[1] Stratification has its negative aspects: an insufficiently free access of air, frequent appearance of mould on the seeds, etc.

The seeds of most fruit plants may be injured by frost only in the following cases: firstly, when they have not yet ripened and contain the excessive moisture of substances that have not completed their process; secondly, when seeds get into an environment where there is just enough moisture and heat for the seeds to germinate, and as a result the process of germination starts, so that frosts which have set in may injure the seeds; and, thirdly, when planted seeds are subjected to excessive and prolonged dampness. In such cases even when there is not enough heat for the process of germination, the seeds may, so to speak, mechanically absorb moisture and swell, and later with the advent of frosts perish in consequence of the rupture of all tissue due to the expansion of the parts that have water frozen in them. That is why many fruit growers willy-nilly prefer stratification for the winter.

In conclusion, I consider it useful to refer to experiments undertaken by foreign scientists involving resistance by dry seeds to the lowest temperatures. These experiments were formerly conducted by such scientists as Romanes, de Candolle, Pictet and others. They subjected seeds to severe cold, to confinement in vacuum tubes and to the action of various gases or steam. Then followed tests with liquid air which produced temperatures of -183° to -192°R.

Brown and Escombe ascertained in Dewar's laboratory that the vitality of the seeds of various plants, as, for example, Umbelliferae and other grasses, is not lost even after being exposed to such a low temperature for as long as 110 hours. After Dewar discovered liquid hydrogen it became possible to obtain a temperature of -250°, which is close to the so-called absolute zero temperature, below which cooling is no longer possible. Next on the program was to test the vitality of the germ of a seed in the extraordinary cold of liquid hydrogen. For this test seeds of the following plants were selected: wheat, barley, mustard, pea, pumpkin and others, and only such as could germinate. The first test consisted in subjecting some of the seeds to freezing for a half hour until the temperature of liquid hydrogen was reached. After first wrapping the seeds in tinfoil Professor Dewar placed them in a glass tube which he cooled first in liquid air and then in liquid hydrogen, i.e., in a temperature of -250°.

When the director of Kew Gardens later planted these seeds in the usual manner, the shoots were normal. A more difficult test was conducted with five other kinds of seeds, which had lain in liquid hydrogen a full six hours without being in any way protected so that they could absorb this incredibly cold liquid.

Dewar, who sent them to Kew Gardens, assumed that these seeds certainly would perish, if cold kills them at all. Yet they sprouted splendidly. It follows from these facts that the state of the protoplasm which is called life cannot be disturbed by cold. Lord Lister considers this discovery to be a fact of extraordinary importance for the comprehension of life in general and its manifold manifestations in particular.

Is this really the case? For my part I am unable to confirm it. But one

cannot help regretting a great shortcoming in all of these tests, namely, that we have been left in ignorance of the influence of such temperatures on the quality of the plants grown from seeds that were subjected to these tests. Although we, fruit growers and especially originators of new varieties of fruit plants, cannot in our practical work meet with such low temperatures, nevertheless it would be interesting to know what influence this maximum cold exerts on the qualities of the seeds and the seedlings obtained from them. The fact that the life of the seeds was preserved cannot serve as evidence that the seeds have not suffered the loss of some of their other properties.

First published in 1915 in
Sadovod, No. 4

NEW HARDY APPLE-TREE VARIETIES FOR NORTHERNMOST LOCALITIES OF APPLE-TREE CULTIVATION

In my work of breeding new fruit-tree varieties from seeds, in addition to the main object which is to improve the assortment of these plants for the central zone of Russia, I have always had in mind the great need for developing hardy varieties for the northernmost parts of the zone of fruit-tree cultivation. Among such localities are the Vologda, Perm and Olonets provinces in European Russia and all the provinces of the central zone of Siberia. All of these provinces and localities have as yet absolutely no cultivated apple-tree varieties suitable for their rigorous climate. In view of the very limited number and inferior flavour of other local fruit-plant varieties this is a rather tangible deficiency in the population's diet. Hitherto many people have been convinced that the cultivation of garden varieties of apple trees is unthinkable in localities with such a rigorous climate. This essentially erroneous idea was based in the main on numerous unsuccessful attempts by inhabitants of these localities to plant orchards of old, cultivated apple-tree varieties bred in Europe. Brought in from the West, these trees, with very few exceptions, really did prove incapable of withstanding the local frosts, being killed by them in the very first winters. Some of these varieties, indeed, perished solely because of their delicate constitutions, whereas others, though actually quite hardy to severe frosts, were killed by them only because the warm summer season is too short for the tree's young growth fully to ripen, so that the plant is caught by the severe autumn frosts while the sap is in full movement. These are, essentially, the sole causes for the failures of the local amateur fruit growers. But to conclude from these failures that it is impossible to grow apple orchards in those localities, I repeat, is quite wrong. It is wrong because the causes of failure referred to are not an insurmountable obstacle and it is quite possible to avoid their effect. All that is required for the purpose is to change the method of getting fruit-plant varieties for planting in their orchards. Trees of cultivated

varieties that have been bred in warmer countries for planting in the open will be quite unsuitable in the given case. The most certain and reliable method here is to breed one's own local varieties from seeds obtained from the fruits of local wild-fruit trees the blossoms of which have been fertilized with pollen from cultivated, even if non-hardy varieties from the nearest warmer localities. For this purpose the northern fruit grower should, of course, have two or three trees of these varieties planted in baskets or tubs so that in winter the trees may be taken indoors where the temperature could not be less than 10 to 15° below zero. In spring, when the snow melts these tub-trees are taken out into the orchard, where the blossoms of local wild or semicultivated varieties planted in advance in the orchard to serve as maternal plants are fertilized with their pollen.

As regards selection of varieties to serve as male parents, not more than two or three cultivated varieties should be obtained from the nearest possible nursery and planted in baskets or tubs; they should, however, be the most frost-hardy varieties obtainable and such as complete their summer growth early and are prolific. Of our old cultivated varieties, Bely Naliv, Anis and all its variations, Grushovka Moskovskaya, small-sized Skrizhapel, Arkad and a few early varieties of the Volga area meet these requirements best. Of the new varieties bred by me even more suitable for the purpose are Slavyanka, Oleg and especially all large-fruited hybrids obtained from crossing Russian cultivated varieties with the Kitaika (*Pyrus prunifolia*); of the latter, the latest hybrid bred by me—from an Anis and a Kitaika, which I named Kitaika Anisovaya, is remarkably suitable in every respect.

The tree of this new variety is extremely hardy, amazingly prolific and finishes its summer growth particularly early.

The fruits possess a splendid flavour, are the size of a silver ruble and are arranged on the fruit-spur in clusters of seven or nine apples; they ripen early in July, but are fit for use long before they are fully ripe. It is a rather low tree, and begins to bear fruit remarkably early, in the fifth year after emerging from the seed. The flesh of the fruits has a delicate, soft and juicy constitution and a pleasant sour-sweet taste; the fruits keep fresh for about three weeks.

The only defect of this variety is the specific fragrance which, although pleasing to people, attracts swarms of insects, such as wasps, flies, bees and various kinds of butterflies, that cause quite considerable damage to the fruits while they are ripening.

The latter, I imagine, will occur to a lesser extent in northern localities, and, above all, this defect will be of no importance whatever there, since the principal role here will be played not by the fruits but by the blossoms and by their pollen, which is absolutely necessary for fertilization. It is for this purpose that I recommend the present variety to northerners. Furthermore, the Kitaika Anisovaya, judging from the fact that its parents are highly frost-resistant varieties, may itself prove a sufficiently hardy variety for the northernmost zones of apple cultivation. The correctness of this sup-

position, however, will be proved only by future experiment. At present, when the experiment is still to be undertaken, it would be rather risky to assert that this variety is already suitable for cultivation in the northern localities referred to.

January 10, 1917

First published in 1917 in
Sad i Ogorod, Nos. 3-5

WHAT WE SHOULD STRIVE FOR IN BREEDING NEW VARIETIES OF FRUIT PLANTS[1]

Cherry: 1. In breeding new varieties of cherries one should strive, first and foremost, to evolve plants of *dwarf size*, because the picking of the crop from tall trees and the protection of the fruit from birds is very difficult, tall trees should therefore be avoided.

2. Bigger size, sweeter flavour, rich pulp, as well as *small stones* should be regarded as desirable properties.

3. Next, fruits that ripen *early* or very *late* should be given preference.

4. *Good yields*, self-fertility, *ability* of the flowers *to withstand* early spring frosts, and of the trees to withstand winter frosts.

5. Resistance to gummosis and fungous diseases affecting the leaves.

6. The best varieties can be obtained by crossing the earliest maturing sweet cherries with the Ural pear-shaped cherry.

7. It has been established of late that it is possible to obtain hybrids of cherries or sweet cherries by crossing with bird cherries; here varieties with good yield, and splendid flavour and fragrance may be expected, particularly by crossing the black sweet cherry with the Virginia chokecherry.

8. For natural crossing, the Virginia chokecherry should be planted together with the Zakharovskaya cherry because the pollen of the latter is not suitable for self-pollination and the fruit sets only from pollen of other varieties, hence if fruits are obtained they would result from fertilization by bird-cherry pollen.

In plums, the first, important thing is *big size* of the fruit, their *flavour*, fine *colour* and, what is most important, more *frequent crop years*; next comes a smaller size of the stone that would be more easily separated from the pulp, early or late ripening, and hardiness. The best hybrids are easily obtained by crossing Green Reine Claude with damson or Vetluzhanka which possess great hardiness. Next, preference should be given to varieties not disposed to gummosis; to varieties whose flowers can best withstand the early morning frosts, and have more crop years.

Apricots. By now I have introduced the cultivation in Central Russia of a variety of edible apricot from Mongolia; it stands winter frost well, is per-

[1] Notes from I. V. Michurin's diary.—*Ed.*

fectly constant and breeds true, but with fruit of small size. To improve this variety it is necessary to breed several consecutive generations obtained from seed and cross them with the well-known cultivated French variety of abricot-Pêche since the latter possesses the greatest hardihood among delicate varieties, produces big fruit of excellent flavour and, moreover, its seeds can produce good strains for cultivation.

The process of crossing can be learned by anyone who wishes to study it, but in order to make a discriminate selection of plants for crossing it is necessary, first of all, to know what properties are desirable in the new variety. Then it is necessary to know the properties of the old varieties so as to pick the most suitable ones.

Thus, for example, we wish to obtain a variety of cherry with the following properties: 1) As low a height of the tree as possible, 2) big size of fruit, 3) sweet pulp, 4) abundant crop, 5) hardiness, etc. To obtain such a variety we have to choose for mating plants of existing old varieties of: 1) the lowest growth, 2) the biggest fruit, 3) sweeter taste, 4) bigger yield, 5) greater hardiness. These requirements can be met by choosing the following: for low growth of tree and big size of fruit, the Urals pear-shaped Griotte; for sweet flavour, one should choose from our varieties of sweet cherries, but since the latter are mostly non-hardy in our parts, we must confine ourselves, for the time being, to the hardy Pervenets variety I produced or, still better, the new Michurin sweet cherry I bred recently, since it can withstand frost and does not suffer from gummosis on light sandy soil with average precipitation. If the small-sized Ural cherry tree is not available, one can use the Vladimir Roditeleva cherry instead, because it is of medium size, hardy and has fruit that are not sour.

It is best to take for paternal plants the sweet cherry and its varieties at an early age and for maternal plants the Ural or Roditeleva cherry, but of an older age.

Lately (since 1919) it has been proved that it is possible to cross the bird cherry with the sour cherry. This offers the opportunity of obtaining hybrids of the Virginia chokecherry with cherries of sweet varieties. High-yield cherries could be thus obtained possessing the fragrance of the bird cherry. In the autumn of 1922, on the western side of the nursery one four-year-old *Zakharovskaya cherry tree* (which is not self-sterile) was planted for this purpose together with the *Virginia chokecherry* grown by layering which had larger rose-coloured fruits and long clusters; also in the autumn of 1923 a two-year seedling of the Virginia chokecherry was planted for future natural crossing. To breed early-ripening varieties of cherries it is necessary to take the Michurin cherry as a maternal plant and the Early Kent and May Duke as paternal plants.

1924

TO THE INHABITANTS OF THE SEVERE SIBERIAN TAIGA

On the vast territory of the U.S.S.R., particularly in its northern parts, there are many places where, as a result of the severe climate, the inhabitants are almost entirely deprived of the opportunity of cultivating any fruit trees the yield of which could improve their poor diet. Most of the population in those places only use the fruits of wild fruit and berry plant varieties like the Siberian crab which are only a little bigger than a pea and are considered almost inedible by people in Central Russia. The same may be said of several varieties of currant, raspberries and nuts found in woods. There you have all that the rigorous Nature of those areas can offer. And if man makes no attempt to intervene, change and improve these meagre gifts of Nature for his own advantage, the existing situation, it goes without saying, will continue indefinitely. Yet the climatic conditions of those parts are far from being so unmerciful as to allow of no improvement whatsoever in their local wild fruit-plant varieties. Let us analyze in detail how far this task may be fulfilled.

First of all let us take note that notwithstanding the relatively longer winters obtaining in many of these places, where temperatures of 40°R. below freezing point are registered, the summers, though short, are usually warm enough to permit full ripening of many summer varieties of Central Russian apple trees. In winter all such apple trees are killed by the frost down to the snow line, but everything below the snow's protective layer always remains undamaged by the frosts. Now this phenomenon indicates a way out of the difficult situation, a possibility to surmount all obstacles. The fact is that with abundant precipitations in winter in these localities the snow layer most of the time is a metre or more thick, and, protected by such cover, many of our apple-tree varieties can easily withstand the severest frosts. They are not suitable for cultivation in those areas merely because trees commence to bear fruit only after they have grown tall with the crown rising above the layer of snow, wherefore they are killed by frost each year before they can bear fruit. To avoid this a trained culture could of course be employed. Trees could be trained to grow in the form of low horizontal cordons, and such a culture could be developed from our *summer varieties, especially those which have the good reputation of being outstandingly frost-resistant,* as, for example, Bely Naliv, Anis, Grushovka, etc. For the time being, however, all this is impossible firstly, if for no other reason than that the blossoms of the varieties referred to are rather sensitive to the spring morning frosts, and even in our parts, in European Russia, they are not infrequently killed by these frosts; secondly, it is quite likely that no people possessing the required knowledge will be found for raising trained cultures in the wilds of the Siberian taiga.

We get an entirely different picture by introducing in those places the cultivation of a variety of a new, improved Siberian crab bred by me, obtained by fertilizing with the pollen of a wild Siberian crab the blossoms

of a hybrid of the Crimean Kandil Sinap and the Kitaika. The variety is distinguished for thorough frost resistance which it inherited from its male parent, i.e., the Siberian crab; and, what is the chief thing, it possesses an unprecedentedly early commencement of fruit bearing, on one-year-old grafts. Although small in size, only somewhat larger than the ordinary Kitaika, the fruits of this variety, which I named *Tayozhnoye Zimneye,* possess a good flavour, grow abundantly, solidly covering all the sprouts of every young growth beginning with the one-year-olds, and moreover, keep splendidly in winter for two or three months.[1]

Well then, friends, agronomists of Siberia, and, for that matter, also of many localities of European Russia lying near the central range of the Urals, you are afforded the opportunity of testing in practice all the tremendous benefits of my counsel in which the main idea is to advance considerably to the north (a full hundred versts) the northernmost limits of cultivated apple varieties. I shall now explain in detail how this goal may be attained. Let us suppose an inhabitant of Siberia or of the central Urals has grown in his locality a hundred or two seedlings of the local Siberian crab. If then in summer, when the seedlings are two years old, he grafts onto them the buds of my new Tayozhnoye Zimneye, he will in a year's time have a complete crop of fruits on the one-year-old grafts. The same will be the case the following year with the two-year-old growth. Then, let us assume that the three-year-old growth rises above the winter snow layer, and, I repeat, let us assume that everything above the snow level is damaged by the fierce Siberian frosts. Nevertheless, there will be abundant fruits on the lower portions of the bushlike part of the apple tree and the same will be true in subsequent years. Moreover, the owner may from time to time lay out new sections or beds of bud-grafted trees and receive a good income from the sale of the fruits to local consumers. Now, this does not exhaust all the benefits to be derived from this process. The chief thing here is the fact that by planting seeds of the Tayozhnoye Zimneye's local harvest and selecting the seedlings for utmost hardiness, yield, and best flavour qualities, various kinds of new local fruit-tree varieties will be obtained and thereby an opportunity will be presented to lay a firm foundation for cultivating apple trees in these regions.

[1] Unfortunately this new variety has not yet been propagated and there are only four of its trees, one an own-rooted mother plant, and three grafted ten-year-olds, two metres high. Of these, two cuttings will be sent in autumn to any one in Siberia or the Urals who may order them upon payment of only two rubles to cover the expense of packing and shipping.

There are two more apple-tree varieties quite suitable for the Siberian climate: 1) Kitaika Zolotaya Rannaya, a hybrid of a Bely Naliv and a Kitaika, and 2) Anisovaya Kitaika, a hybrid of an Anis and a Kitaika. The fruits of both varieties are notable for particularly early ripening and fine flavour. Although these two varieties are inferior to the Tayozhnoye as regards hardiness and yield, they will, nevertheless, be hardier in Siberia than all others of our cultivated varieties. Cuttings will be sent by way of exchange for local *Amygdaluses,* of which we are greatly in need.

Without this it is positively impossible to establish fruit growing not only in Siberian localities with their rigorous climate, but even in regions with a warm climate fruit growing is not successful without local varieties.

Let us take the obvious case of the western seacoast of the Caucasus, the Sochi district, an area possessing such a warm climate that winter temperatures such as were experienced in the present year of 1925 are considered very rare phenomena. In many orchards in this district peaches, tangerines, laurel and almonds, grapes, as well as the best varieties of apple and pear trees grow in the open. And yet fruit growing there is about as bad as it could be, as may be seen from the fact that not infrequently a whole dessiatin of orchard brings in not more than ten rubles income.

And all this is due to the fact that they do not raise their own local varieties, but different varieties of foreign origin which, owing to their structure are not at all suitable for the soil and climate of that locality. And yet sixty or seventy years ago, when this locality was in the possession of the Circassians the territory was famed for the abundance of all kinds of fruits. But when the Caucasus was conquered by the Russians and the Circassians had to migrate, they cut down nearly all the fruit trees before leaving, and the new settlers, mostly various kinds of bourgeois, rich people, merely for satisfying their fancy planted foreign varieties, quite unsuitable for the conditions of the territory.[1]

Kozlov, Tambov Province,
Michurin State Pomological Nursery

First published in 1925 in
Sad i Ogorod, No. 2

TO SIBERIAN FRUIT GROWERS

Of late I have very often come across in the press and in correspondence from many inhabitants of Siberia and the Urals complaints of the constant failure of their attempts to breed improved varieties of fruit plants by planting seeds of European cultivated varieties. Practically all the seedlings without exception grown from such plantings were destroyed by frost, and even the few hybrid seedlings obtained by some amateurs by crossing European varieties with local hardy species of their area met the same fate. Here we shall not touch upon the utter destruction of varieties of fruit plants transplanted in their entirety after having been fully grown in European Russia. In this respect no methods can be of help, and all endeavours will result in a vain expenditure of time and labour. And even if perchance a plant here and there is successfully preserved for a few years, in the end their destruction is inevitable. However, new varieties of fruit plants grown in Siberia from the seeds of European varieties, or their hybrids, have, if I am not mistaken, some chances of success. The thing is that in propagating seedlings obtained from European varieties all Siberians sow the

[1] Details of this may be found in the book *Fruit Growing on Private Lands in the Sochi District*, by the agronomist Kuprianov.

seeds in beds of rich Siberian soil cultivated in the usual manner, or, what is worse, thoroughly fertilized and deeply-loosened, and, sometimes, as some of them have written, watered with liquid fertilizer even after the seedlings have sprouted. As a result, the seedlings grow most luxuriantly, develop a mighty growth, sometimes reaching the fabulous size of two metres when one year old. All of this, true, is at first pleasing to the fruit grower and many suppose that that is exactly as it should be. But, as a matter of fact, here is to be found the gross error which leads to the destruction of all hybrid seedlings grown by this method. I state all this on the basis of my own experience. They kept repeating to themselves that the entire art of the fruit grower is to employ various means to secure the luxuriant growth of both the seedlings of wild plants to serve as stocks, and of grafted trees; and they apply it everywhere, including the breeding of new varieties of fruit plants, without thinking at all of the great harm they are doing. This applies, particularly, to Siberians and their rich, practically virgin soil.

I myself, in the early period of my work, suffered heavy loss in the shape of several years of wasted labour. The hybrid seedlings obtained by crossing the best foreign varieties with local frost-resisting varieties that were grown in beds of richly fertilized and deeply cultivated soil were killed by frost during the first two or three winters; only in the latter part of the 'eighties, when the soil at the end of one of the planted beds was by chance sandy and of poor quality did about a dozen hybrid seedlings grown on it prove to be completely frost-resistant. I observed this phenomenon, which at that time appeared to me paradoxical. How could it be that seedlings whose development was weaker turned out to be hardy whereas the strong ones perished?

As a matter of fact this phenomenon, which is fully in conformity with natural laws, appeared to me incomprehensible. Nevertheless, soon afterwards I began deliberately to plant in beds of poor soil and then, having become definitely convinced of the superiority of this method, I was even forced to sell the old plot of land with rich black soil on which the nursery I had established existed for ten years, and in its place I managed to find and buy a patch of land with the poorest kind of washed-away soil.

Further work completely cleared up all the details of acclimatizing hybrid seedlings, as follows: it appears that in the structure of the organisms of hybrid seedlings reared in rich soil all the genes (i.e., characters) transmitted by inheritance to the hybrid by the delicate foreign varieties are too predominant; that, and also the superfluous obesity and extremely rapid growth of the hybrids due to which the movement of the sap does not cease by autumn, are the cause of seedlings being destroyed by frost. On the other hand, although rearing in poor soil yields for selection a much smaller quantity of highly cultivated hybrids, they will all possess enough hardiness with respect to local climatic conditions, and, what is most important, this property of hardiness increases as the seedlings grow to maturity, becomes fully stable when the trees grown from seedlings as well as graftings from them on stocks are transplanted into rich soil. In a word, in their early life seedlings

that have developed frost resistance are thoroughly dependable material for rearing new varieties in a given locality.

Thus, all fruit growers operating in localities where the climate is severe, in breeding local hardy forms of fruit plants from seeds obtained from varieties growing in warmer countries, must under no circumstances apply to seedlings extra measures for stimulating a luxuriant growth during the period of their early development to full maturity; on the contrary, it is necessary to try to help the plants to acquire the property of finishing their growth and of their wood ripening in a shorter vegetative period by substituting soil of poor composition and by nipping the ends of the young annual growth of the shoots at the end of the summer.

As far as the employment of other useful methods is concerned, my numerous experiments indicate that it is most important that the beds for seedlings for the first three to five years of their growth after sprouting from the seed, should as far as possible be set in places protected from winds and in general from strong air currents, in a word, where it is calm. This condition is of tremendous importance in view of the fact that young seedlings require as a stimulant to their growth carbon dioxide, which is absorbed by its leaves in daytime. In windy areas, however, carbon dioxide (CO_2), one of the relatively heavy gases, found in a more condensed form in the lower strata of the atmosphere above the surface of the soil, is blown away by the wind, thereby depriving the plant of necessary material for its growth, and, strange as it may seem, hybrid seedlings in such localities, notwithstanding the better composition of the soil, manifest in their form-building a strong inclination toward the wild species. Even selected three-year-olds transplanted to such places run wild, and, on the other hand, in sheltered places even where the soil is poorer a far greater percentage of individuals possessing cultivated qualities is obtained when selecting the grown plants.

First published in 1927 in
Ussuriiskoye Sadovodstvo i Ogorodnichestvo, No. 2-3

TO FRUIT GROWERS OF THE URALS AND SIBERIA

Cases of several varieties of fruit trees taken from localities west of the Urals having in part proved hardy in the Urals, as reported by Kazantsev (see *Sibirskoye Plodovodstvo i Ogorodnichestvo*, No. 3), and others, have led fruit growers in the Urals to doubt the correctness of my assertion that fruit growing in that region should not be founded on varieties of fruit trees taken from countries further to the west of the Urals, and that it is a gross mistake to hope that the notorious method of acclimatizing such varieties could serve the purposes of commercial horticulture.

I repeat, the cases of hardiness cited merely show that these rare varieties, when still in their habitat fortuitously possessed the property of enduring lower temperatures and other climatic conditions more rigorous than

those prevailing in their habitat. The transplantation of such varieties, which do not undergo changes in their constitution, is called not acclimatization, but naturalization. Though transplanting of this kind does sometimes yield satisfactory results in small non-commercial gardens, they are, nevertheless, extremely risky for extensive commercial plantations; in particularly unfavourable years such plants are apt to perish to the last one of them, whereas those bred locally from seeds obtained by crossing the local wild species with western varieties are always completely dependable material, if for no other reason than that such seedlings from the earliest stage of their development build up the texture of their organism under the constant influence of the external local climatic conditions. That is why they will not have to fear any adversities in the Urals area or far-off Siberia.

The better of the hybrid varieties obtained in this manner should be crossed again after the first fruit bearing, this time with the best selected western foreign varieties, by fertilizing with the pollen of the latter the blossoms of their seedlings, which, in these crossings, are to serve as the maternal plants. It is this second series of hybrid seedlings that will yield varieties fully capable of competing with the best foreign ones, despite the enormous difference between the climatic conditions of the Urals and Siberia and those of Western Europe.

And so, I assert again that "one swallow does not make a summer"; what has worked out well with one may perish with a score of others. I warn against mistakes because, at the end of the eighties of the past century, I myself experienced a most cruel disappointment from similar false acclimatizations.

With reference to the question of what to pollinate and what with—a delicate variety with a hardy one, or vice versa, I must say that only those properties and characters of both parents will predominate in the hybrids the development of which is favoured by local external conditions, and that in general the maternal plant will more fully transmit its properties hereditarily. Hence the conclusion that it is better always to use the hardier varieties as the maternal plant, although such a combination will result in new varieties of fruits of inferior flavour and size, but then they will be distinguished for greater hardiness with respect to the different adversities of a rigorous climate.

As regards grapes, here is what I wrote on the subject to Professor Tairov of the Odessa Viticulture Station for publication in the *Symposium on Grape Growing* that is being published by him.

All fortuitous grape cultures in Central Russian localities (old varieties and also the twenty-odd newly-bred hardy varieties) should be deemed merely amateur ones, far from suitable for extensive commercial plantation in the central zone of the Soviet Union. The delay in obtaining thoroughly hardy varieties of grapes, a delay continuing to this day, is due to the fact that thoroughly continental climatic conditions and belated spring morning frosts not infrequently utterly kill the young, green growth of the vines and their blossoms at the end of April and in the first half of May. Consequently, there

is a need for such grape varieties as possess (besides resistance to winter frost, good yields, good flavour and early ripening) the capacity to lag by more than a month in beginning spring growth, or quickly to replace by a second growth parts lost as a result of spring frosts. Inasmuch, however, as it is next to impossible to achieve the first requirement, i.e., it is impossible to delay the spring growth of the vine for so long an interval, it becomes obvious that success can be hoped for only in the cultivation of such varieties as have the capacity rapidly to restore the parts killed by frost and, besides, are able to yield ripe berries before the first autumn frosts. In a word, it is necessary to obtain new varieties of grapes possessing the quickest possible tempo for building up the cellular tissue of the vines.

During the past decade I observed one almost paradoxical phenomenon in the life of the grapevine, namely, that the majority of hybrid seedlings grown from seed in early spring produced varieties with a slow tempo of tissue-building of the new growth and later-ripening berries, and, on the contrary, seedlings grown from seed late in the season (during the second half of June) produced varieties with a rapid tempo of growth-building and early-ripening berries. With the further development of the hybrid seedling (especially if the pair of parental plants were taken from remote habitats even if they belong to the same genus), the rapid tempo of growth-building becomes permanently fixed in its organism. This phenomenon has been noted by me also among many other plant species.

This past summer one of such seedlings, a five-year-old, which I named Phoenix, began to blossom only at the beginning of July; nevertheless, it caught up with the other varieties which shed their blossoms as early as the end of May and ripened together with them. It yielded dark-coloured sweet berries with a barely noticeable "foxy" aftertaste due to the collaboration of the Labrusca strain.

You can see from this note of mine that cultivation of grapes is now possible not only in Tambov Province but even in the Urals and Siberia.

This observation is indeed of colossal importance for producing new varieties of fruit plants from seeds, since in addition to grapes, it can very likely be applied also to all other species of fruit plants. Now we see that if man does not conquer Nature, as people are wont to boast, he nevertheless almost always finds a loophole for getting out of a difficult situation.

In conclusion I want to tell about two of my cherry varieties that are hardy in the Urals—Michurin Plodorodnaya and Yubileinaya. These are indeed among the best varieties, particularly the former. Besides possessing a stable hardiness it is the only dependable variety for extensive commercial cultivation owing to its fecundity year in and year out. Even the seedlings of this variety in most cases produce varieties of good yields. To obtain even hardier varieties I would advise that the stones be planted and grown in the Urals and in Siberian localities

The City of Kozlov,
Tambov Province

First published in 1928 in
Sibirskoye Plodovodstvo i Ogorodnichestvo, No. 4

HOW TO GROW FRUIT TREES IN THE URALS

(REPLY TO A LETTER FROM A CHELYABINSK FRUIT GROWER)

In answering letters from amateur fruit growers in the Urals, I have to state, first of all, that as far as I am concerned I most emphatically assert that it is fully possible to establish and carry on commercial fruit growing in the Urals, but on the one sole condition that local fruit-plant varieties are bred from seeds on the spot, whereas all attempts to transfer already existing varieties by bringing whole plants from other provinces, even if the climate there approximates the local Ural climate, will never provide a sound basis for fruit growing in the Ural region. That is an unalterable truth.

Acclimatization is possible only when plants are transferred in the form of seeds. On the basis of my fifty years of labours and a deep study of plant life, I consider acclimatization by the transfer of whole plants or different varieties of them from other countries or localities to be an idle occupation fit only for amateurs who play at fruit growing, and nothing more.

In the present case this estimate is correct if for no other reason than that there is far too great a difference between the climate and soil of the Ural region and those of the localities, even the ones nearest to the Urals, where the cultivated varieties of fruit trees had originated and had been formed.

None of these varieties will be hardy in the Urals and no attempts to cultivate them there will ever yield good results. At best the plants will be sickly and the fruits will be of much poorer quality than these trees yield in their native places. In the end, during some very severe year, the trees will perish. That is the fate of all such acclimatization.

Quite the contrary will be the case with varieties grown from seeds in that locality, when the constitution of the grown tree will, from the earliest stage of its development, from the seed, have been moulded under the constant influence of the local climate and soil.

All such seedlings selected for hardiness, good quality of fruits and for yield will not be affected by the adversities of the Ural area—they will be accustomed to them.

And so, it is only on the basis of these varieties that amateur fruit growers can make fruit growing in the Urals a paying proposition.

Now I shall proceed to indicate the best methods of cultivating fruit seedlings.

Here I have, first of all, to persuade beginners in the realm of fruit growing and acclimatizing not to accept the opinion, which has taken root everywhere, that only a wilding will be obtained from the seed of a cultivated variety. That is not true. Not all such seedlings will yield small-sized fruits unfit for consumption; many of them will yield good kinds of fruit. Its quality depends, firstly, on the variety taken for planting, and, secondly,

on the care given the seedlings until they fully develop into trees and yield their first fruits.

Here is an example: as a variety derived from a wilding the Antonovka produces seedlings mostly of the wild type, whereas the Bellefleur-Kitaika or the Chelebi Alma and its hybrids, also the various kinds of Anis, Skrizhapels and the Crimean Sinaps, with proper care produce seedlings that are almost entirely of the good large-fruited cultivated varieties, but of varying quality as to flavour, depending on the diverse influences of the local climatic and soil conditions during the first years of their development.

For example, if the vegetative period during the seedling's first year (the period in which the plant develops its vital forces, grows) happens to be warm and sufficiently humid, and what is most important, the spring and summer are calm, then the seedlings will in their constitution strongly deviate toward the better qualities of the cultivated varieties. On the contrary, a cold and dry and, particularly, a stormy spring and summer will inevitably have a deleterious effect on the structure of the seedlings, strongly inclining them towards the wild type.

As to what kind of soil is best for rearing seedlings from seeds of cultivated varieties, in the present instance, regardless of the established rules of ordinary fruit growing, a nursery should not be set up on rich and deeply cultivated soil, but on somewhat poor soil of medium humidity, *but without fail in a place that is as much as possible protected from the winds and early sunlight.* It is better, therefore, to plant mainly in places that slope to the west and not to the east or south.

Of course, if reared in well-cultivated and rich soil, the number of seedlings with culture qualities would be much larger, but then they would develop overwhelmingly the properties of the cultivated parents (forebears), which would lessen their hardiness—adaptability to severe climatic conditions. These seedlings would be killed by frost during the very first winters. On the contrary, when reared on poor local soil the number of hardy seedlings at selection is greater, and many among them also have fruits of good flavour. But what is particularly important is that among the seedlings reared on west slopes, varieties are obtained that blossom late, towards the end of spring, and this is of great importance in localities where belated spring morning frosts kill the blossoms of fruit trees.

Seeds of cultivated types for rearing new local varieties should be planted in beds in autumn, and in late autumn or winter in boxes half a square metre in area and 18 cm. high, filled with sandy soil.

The varieties of seeds in the box should be separated by sticking narrow strips of glass into the soil and marking each plot with a label showing the number or name of the strain.

The box, then, should be completely covered with a layer of snow 18 cm. thick and kept that way in the house for about three days, after which the box should be taken out into the orchard where it is again covered with snow and left until spring.

In spring, after the seedlings have developed three leaves above the cotyledons (the primary pair of leaves) they should be lined out, i.e., transplanted to a bed 36 cm. apart and shaded with matting for the first three or four days.[1] The following days the bed should be watered sufficiently and the soil should be kept loose and weeded all through the summer.

In the third spring a selection should be made of the seedlings with respect to appearance and frost-hardiness. The best seedlings should be planted not less than two metres apart, and left in their places until they bear fruit. Each year, however, the superfluous small lateral branches should be removed by cutting, and the growth should be checked by cutting away one-third of the growth of shoots at the beginning of September. With the beginning of fruit bearing a final selection and appraisal should be made of the variety for the quality of the fruits. But final judgment of the variety's merits cannot be made during the first years of fruit bearing as the fruits become perfected only gradually, in the course of several years.

Quite often the fruits of the first fruit bearing year differ very little from the sour fruits of wildings. But in subsequent years they gradually improve and assume the shape and qualities of the best cultivated varieties.

The trees thus selected are propagated by the grafting of cuttings taken from them on to young stocks, not more than two years old, grown from local hardy wild varieties.

Then, further to improve the qualities of the local varieties of fruit plants *hybridization* is employed, i.e., these local varieties are crossed with the best-quality foreign varieties. For this purpose good varieties are reared in specially built winter sheds, or in tubs or baskets which in winter are removed to cellars, or are protected by some reliable covering.

Crossing consists of transferring pollen from the blossoms of good varieties on to the blossoms of the trees of local varieties after the latter have first been carefully castrated (i.e., after the stamens, the male sex organs, have been removed and only the pistils, the female organs, left).

The same procedure should be followed with the seeds obtained from the fruits of such crossing. Rearing and selection should also be done in the same way.

And then, as a result of all this, after the second period of rearing your own varieties, you may rest assured that, notwithstanding the relatively rigorous Urals climate, fruit-plant strains of excellent quality and thorough hardiness will be obtained, such as are quite suitable for commercial fruit growing in the Urals.

[1] The seedlings should be taken out of the bed or box by means of a small spade or the wide blade of a knife, and after carefully freeing them of earth, the long rootlets should be cut with a sharp knife, leaving them one-half or two-thirds of their original length. The seedlings, then, should be lined out in the little pockets prepared for them (i. e., planted in a bed in pockets driven in by small pegs). The operation should be performed as quickly as possible to prevent the plant's root being exposed to the harmful action of the sun or wind.

For the first planting, amateur fruit growers should order seeds in localities of the central and northern parts of Russia with the request that the seeds of the relatively hardier fruit-plant varieties be sent, or, better still, should make the trip themselves to purchase the fruits and then, at home, extract the seeds from them.

First published in 1928 in
Uralskoye Ogorodnichestvo i Sadovodstvo, No. 1

PLANTING OF FRUIT-TREE SHELTER BELTS FOR FIELDS

This spring I heard for the first time of the intention of some regional workers to plant fruit and forest plants as shelter belts around large areas of grain crops.

The purpose of such shelter belts is to keep and accumulate snow on our fields in winter time, which, of course, should bring about the retention of a large amount of moisture in the soil in the spring. The effects of the aridity of our Central Black-Earth Region, resulting from its thoroughly continental location, will thus be eliminated to a fairly considerable extent, and the yield of grain crops will greatly increase.

There is obviously no reason to doubt that the realization of such a plan will be of vast benefit—its usefulness is unquestionable. But in tackling this task we shall encounter rather serious difficulties, and we must first of all consider how to eliminate them.

Let us examine each detail separately. Firstly, what types of plants offer the greatest advantage? Of course, such as apart from performing their main function, which is to protect the soil from wind erosion in spring and summer and to accumulate snow in winter, may serve as a source of income thanks to their other qualities.

1. The planting of forest trees, for example, may later supply building materials.
2. The planting of fruit trees will yield an income from the fruit crops.
3. The planting of small-fruit shrubs in solid rows between tall trees promises a considerable income from the harvest of cherries, plums, nuts, etc.

Now, in planting forest trees it is essential to choose the fastest-growing types of trees—poplars, American maple, ash—alternating with trees producing more valuable wood, such as oak, etc. Here no serious difficulties will be encountered either in regard to choice or in regard to the possibilities of finding sufficiently large supplies of planting material.

However, the planting of shelter belts made up of fruit trees will involve many difficulties both in regard to the choice of species and varieties and, particularly, on account of insufficient supplies of planting material to meet the large requirements. For it is proposed to protect not just some scores of

hectares of grain crops, but hundreds of thousands of hectares, and, consequently, the quantity of planting material required will run into tens and hundreds of millions. Where are such quantities to be found? Besides, there will be the practically insoluble problem of how to protect such types of plants from domestic animals, hares, mice, moles, and often also biped pests.

We must not let ourselves be reassured by suppositions that it may be possible to protect apple and pear trees by wrapping them up with various kinds of reeds and weeds in the autumn. Firstly, such protection in the

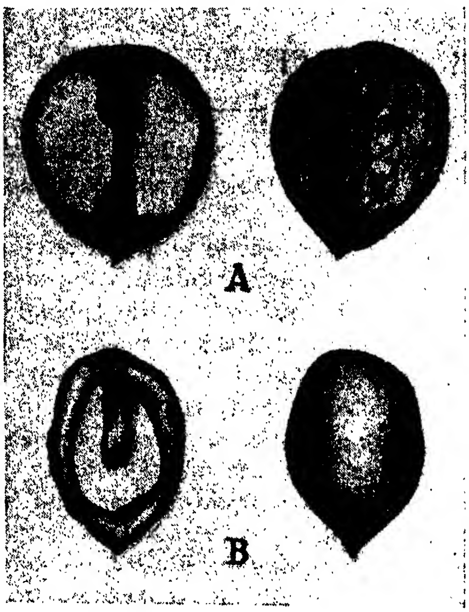


Fig. 192. Nuts: *A*—walnut (*Juglans regia*), *B*—Manchurian nut (*Juglans mandshurica*)

course of five or ten long years will be frightfully expensive, and, secondly, it will not fully serve its purpose. And it is certainly absolutely ridiculous to suppose that the plantings can be protected from hares by watchmen and dogs.

Besides, it will be utterly unsuitable to plant in narrow shelter belts in open fields our old cultivated varieties of fruit trees spoiled by man's excessive care in the course of thousands of years, as a result of which they have lost the capacity for self-activity and have become unfit for the struggle against the rigours of the external environment.

In brief, I doubt whether cultivated varieties of apple and pear trees can be used for this purpose. Wild, pure forest species could fully endure the conditions, but what income can be expected from them? Their fruits are of too little value—the game is not worth the candle.

We get an entirely different picture when we examine the third method—that of planting shelter belts of tall and low-growing small-fruit shrubs

Fig. 193. *Prunus tomentosa* (Tomentose sour cherry)

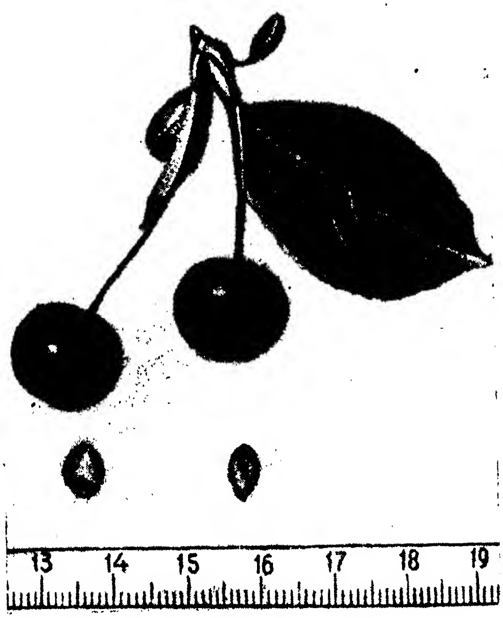


Fig. 194. Polyovka sour cherries

By this method we fully achieve the direct aim of protection against dry winds, and the densely planted rows of shrubs ensure the accumulation of a snow supply in winter. In addition, we can derive considerable income from the fruits and berries.

Long-known and very profitable nut cultures (*Corylus avellana L.*), to which we, for some unknown reason, pay no attention, should be classed as suitable for this type of shelter-belt planting. These plants, with a large

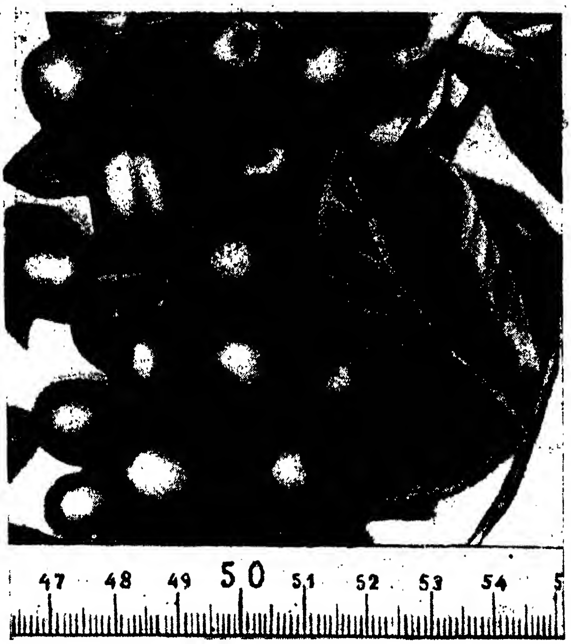


Fig. 195. *Prunus Besseyi Waugh.* (American Sand Cherry)

protein and fat content, are particularly valuable at present, when our food is deficient in fats and proteins.

Since the hardy sorts of the thin-shelled walnut and the thick-shelled Manchurian nut (see Fig. [192], *A—Juglans regia*, and *B*, below, *Juglans mandshurica M.*) in my possession cannot be quickly propagated, we shall not talk of them, but examine some new varieties and species of small-fruit shrubs which I have bred for culture.

1. Take the eastern cherry (*Prunus tomentosa Thbg.*, see Fig. [193]) from East China, which I have bred for complete frost-hardiness and improved fruit qualities.

This shrub, one metre in height, yields every year an abundance of cherries of medium size, juicy, of a sweet flavour and with a very small stone, fully suitable for the production of wine and confectionery. It breeds true when propagated by seed. All this should be regarded as a very great merit. Besides,

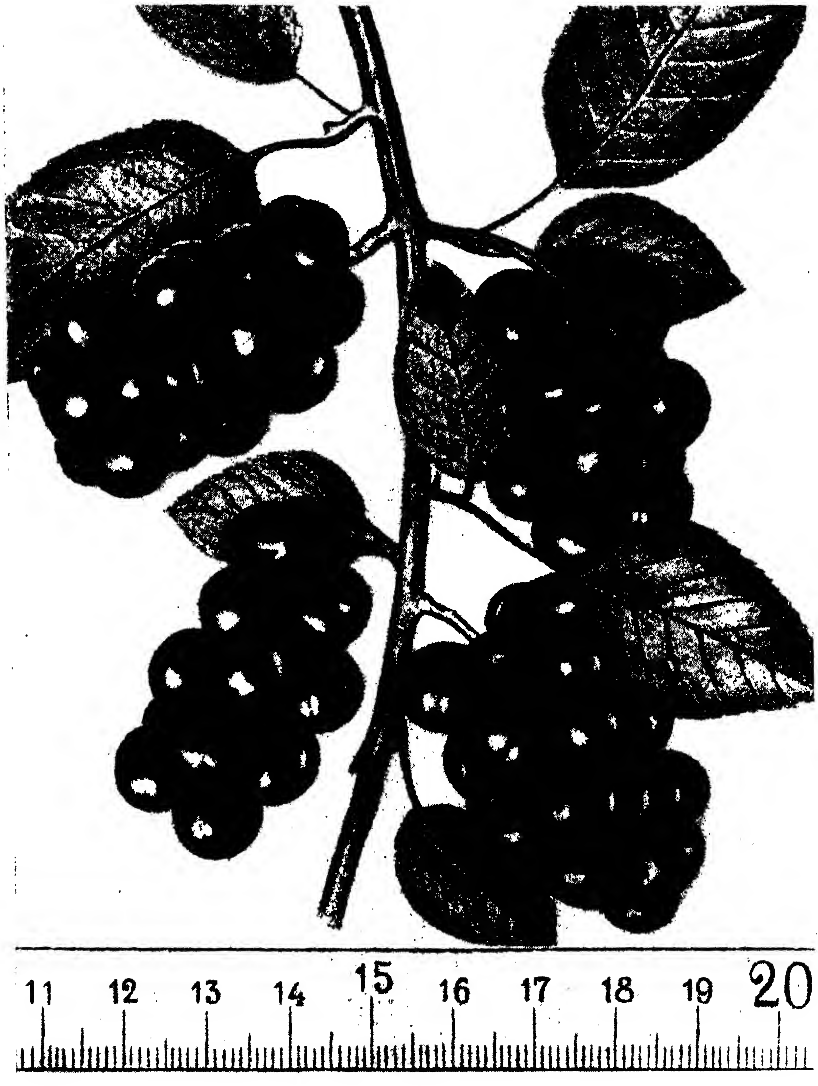


Fig. 196. Pink chokecherry

this plant is never injured by hares, mice or various fungous parasites. It requires practically no care and is satisfied with almost any kind of soil.

2. Polyovka cherry, a new strain which I have bred from hybrids, yields every year an abundant crop of large cherries. The tree is two metres in height. Both the tree and the fruit buds are unquestionably fully frost-hardy. The tree did not suffer in the least during the past two winters with their particularly severe frosts.

It is propagated rapidly from suckers and by grafting.

Fig. 197. Mountain ash hybrid (*Sorbus aucuparia*)

Fig. 198. *Actinidia kolomikta*

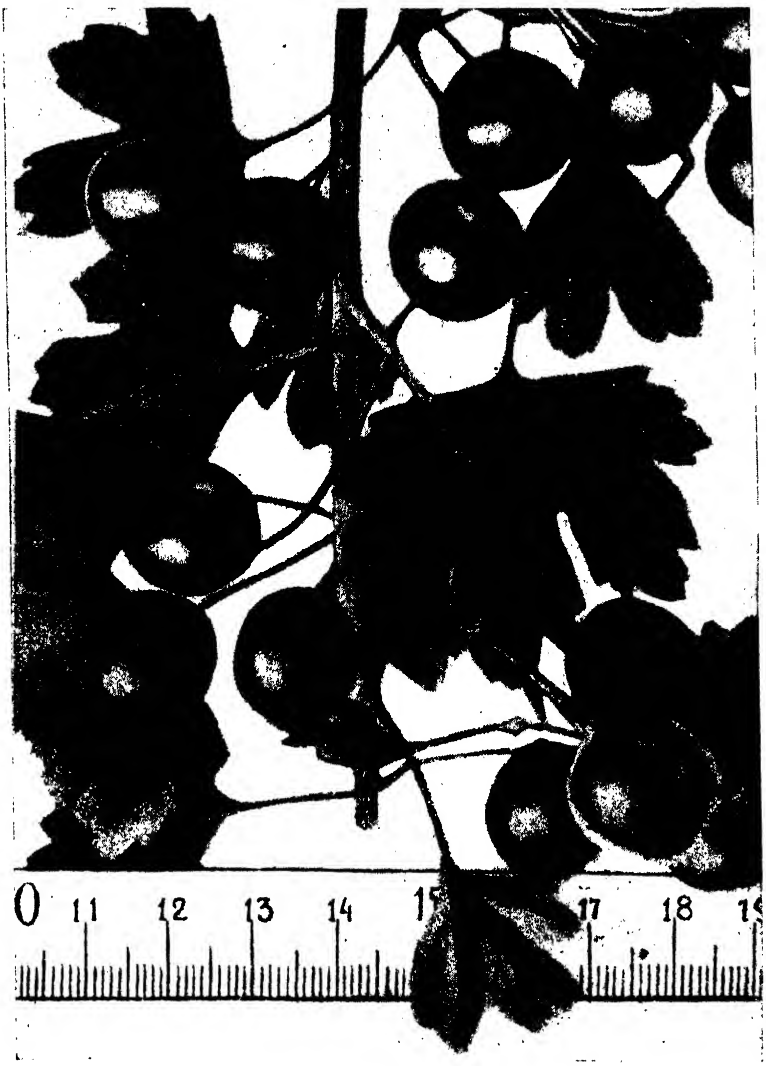


Fig. 199. Zololistaya currant (*Ribes aureum Pursh*)

3. We have also introduced to culture in our parts a selected American Western Sand Cherry (*Prunus Besseyi Waugh.*, see Fig. [195]), also propagated by sowing the stones. The shrub is one metre in height. Its yield is large. This plant is also valuable for hybridization both with all cherry varieties and with plums and apricots.

4. I find the Chinese plum species (*Prunus triflora Roxbg.*), which I have recently bred, suitable for planting in shelter belts. It is unexacting as regards soil, is quite hardy and yields an abundant crop of different-sized

fruits of a beautiful bright colour. It is easily propagated without being grafted, by the sowing of the stones. Its height is from two to four metres.

5. Lastly, some hybrid strains of pink sweet chokecherry (*Pr. virginiana L.*, see Fig. [196]), which I have bred, are suitable for the named purpose. It is very unexacting, hardy and fertile. The tree is two to six metres high, and its remarkably beautiful, *sweet fruits*, of a transparent pink colour that grow in clusters of different shapes, *are suitable both for the preparation of preserves* and for confectionery.

6. And, finally, our traditional mountain ash (*Sorbus aucuparia*, see Fig. [197]), which I have hybridized with other species, has produced several economically valuable varieties with large berries of different colour, from entirely black to deep lilac-red and quite green. The berries, free of any bitterness, are suitable for the preparation of preserves and confectionery.

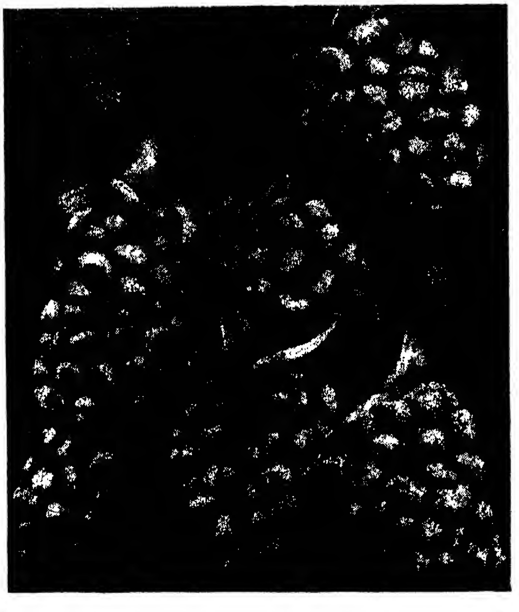


Fig. 200. Texas raspberries

7. I shall now describe some entirely new types of plants I have bred for culture. For example, the Eastern kishmish (*Actinidia kolomikta Max.*, see Fig. [198]). This climbing plant has a big future as a strong rival of the grape in northern regions. The berries—their size that of an average gooseberry—are of an elongated shape, very sweet and exceptionally fragrant and delicate. Selected strains yield large crops and are fully frost-resistant. Picked one week before full ripening, the berries can be shipped long distances. (Has not yet been propagated.)

8. Prickly cherry (*Pr. plagiosperma Oliv.*), as it is called by the indigenous population near the Maskhe River, a tributary of the Ussuri, in the Far Eastern Territory, is a rare plant, which has never been in culture. In appearance it is much like a peach and probably represents its prototype. The fruits, of the size of a large cherry and yellow in colour, have an excellent flavour. The flowers are yellow. It is about two metres in height. (Not yet propagated.)

9. A new variety of currant which I have bred for culture is the large-fruited hybrid Zolotistaya (*Ribes aureum Pursh.*, see Fig. [199]). It is about three metres in height, very frost-hardy and also drought-resistant; is not susceptible to attack by pests; is propagated by cuttings and by the sowing of seeds, with subsequent selection for yield and size of fruits.

10 and 11. Of raspberries introduced into cultivation I mention the hybrids of blackberries with the Texas and Gorshkov raspberries (see Fig. [200]), both producing very large-sized and productive fruits, but in winter their canes must be bent to the ground and slightly covered with weeds or leaves. They are propagated by tip layering (in the second half of August).

By and large, in my opinion it is more expedient in planting shelter belts to use types of trees which grow tall and interspersed with species of small-fruit shrubs which can be propagated by sowing their seeds, by cuttings and by suckers.

First published in 1930 in
Sad i Ogorod TsChO, Nos. 1 and 2

ATTENTION TO FRUIT GROWING

(A REQUEST ADDRESSED TO THE SIXTEENTH PARTY CONGRESS)

We must break with the past and cease living for our own sake only—something that unfortunately has become too deeply rooted in each of us. We must all work for the good of all and the consequent general improvement in the standard of living will afford better conditions to every one of us.

Throughout all my life I firmly adhered to this idea and strove to the utmost to overcome all difficulties. I attempted to improve all that came my way: I have worked in various branches of mechanics and electrical engineering, perfected various instruments, studied apiculture.... But best of all I loved the work of improving cultivated fruit-plant varieties. After having gone through a series of mistakes and having experienced various kinds of failures in the fifty-six years' course of my own practical labour I have achieved in the issue the production of a number of new varieties with increased yielding capacity by means of hybridizing the best delicate foreign varieties of fruit plants with our hardy old local strains.

On the initiative of V. I. Lenin the Government has afforded me the possibility of increasing considerably the scope of my work. Nevertheless, the Kozlov institution alone and the similar experimental nursery at Nikolsk-Ussuriisk are far too insufficient to satisfy the requirements of all the vast republics of the Soviet Union.

Besides, because of the great diversity of climatic conditions in different regions of the U.S.S.R. our experimental station is, naturally, incapable of producing varieties that would suit the conditions of each particular region.

Fruit-plant variety breeding has a great future in our country: firstly, fruit instead of being a dainty will become an essential component in the diet of every workingman; secondly, to combat drought the planting of shelter belts all over our steppe regions has been planned; an idea has recently been advanced *that fruit trees be planted for this purpose instead of forest trees*.

In the nearest future the fields in our Black-Earth Region will acquire an entirely new appearance. The present mix-up of small intermittent patches of land cultivated by individual peasants *will give place to uninterrupted*

wide fertile fields of kolkhozes engirdled with strips of orchards. Field-orchards will be thus created.

The only thing required is the most urgent and energetic work on the propagation of good varieties of fruit trees well suited to the local conditions.

I find it essential to point to the necessity of *organizing experimental stations in every region that would work along the same lines as the Kozlov pomological experimental station.*

As for the cadres of experienced managers for these stations, I have no doubt that such specialists will be found.

I ask the Sixteenth Party Congress to give consideration to this problem.

Director of the Kozlov State Experimental Station, member of the All-Union Association of Scientists and Engineers for the Advancement of Socialist Construction of the U.S.S.R.

Michurin

First published in 1930 in
Nasha Pravda, June 28

BREEDING—A LEVER IN OBTAINING PLANTS IMMUNE TO DISEASES AND PESTS

Scant attention was paid in pre-Revolutionary times to combating diseases and pests of fruit plants. Indeed, there could have been no question of applying anything in the nature of organized and modern economic measures in this sphere. This was due, on the one hand, to the ignorance of the horticulturists and on the other, to the fact that private orchards were scattered about the country and small in size. In fact, the small town orchards were in such a state of neglect that they actually served as breeding grounds for pests.

The following impartial figures, though very incomplete, provide some idea of the ruinous effect of diseases and pests in fruit orchards.

During the imperialist war [1914-18], 28,000 hectares of orchards destroyed by pests and diseases were erased from the list of North Caucasian horticulture. Moreover, the surviving orchards were so infected by pests and fungi as to present a very real threat to the existence of horticulture on the whole Black Sea coast.

Many new diseases and pests unknown before, have spread to our orchards from foreign lands. One example is the gooseberry mildew (*Sphaerotheca*). This fungous disease was totally unknown to our berry growers thirty years ago, but today there is hardly a single variety (with the exception of the American Mountain gooseberry and the hybrid varieties which I produced by crossing cultivated English varieties with the red *Ribes succirubrum* plant) which is not affected by this mildew.

It is generally known that this mildew disease, brought to our country from America via Ireland in 1899-1900, has in the last thirty years affected literally all gooseberry farms in the central, southern and northern belts of the U.S.S.R. All the methods hitherto employed against it have proved of little avail.

Orchard pests and diseases deprive us of almost half of our crops.

That was the case in the old privately-owned orchards. But it should not be the case in the cultured socialist orchards which are now being mechanized on the basis of advanced, modern technology.

Though I attribute great importance to modern methods of eliminating orchard fungi and pests, it is my firm belief, based on many years of experience, that the only correct method lies in plant breeding, in plant hybridization, which make it possible to obtain new varieties of fruit and small-fruit plants immune to diseases and pests. *Hybridization and breeding enable us to develop not only an immune variety, but also to obtain plants with properties and qualities such as are not met with in ordinary horticulture.* In 1903 I crossed the wild Ussurian pear *Pyrus ussuriensis* (maternal parent) with the highly cultivated French pear Beurré Diel (paternal parent) and obtained the only winter variety of pear in the central and northern belts of the U.S.S.R. which, besides being distinguished for its excellent flavour, annual yield, and good storage qualities—it keeps fresh until February—possesses a number of other extremely valuable properties, namely: the bark is resistant to sun scorching; the blossoms can withstand early morning frosts; *both the leaves and the fruits are unaffected by fungi and insects*; the fruits are firmly attached to the branches (each pear weighs 200 grams or more). Nor is that all. The fruits of this pear, which I have named Michurin Beurré Zimnaya, do not decay from mechanical injury, but develop a subereous tissue over the damaged spot which prevents fungi from penetrating into the pulp. But this latter property the fruits acquire only in the absence of organic fertilizers in the soil under the trees; otherwise the fruits lack this quality.

Grapes are another example. Cultivation of grapes in the open in the central belt was never even thought of prior to my work. But now, as a result of my work in plant breeding and experiments in hybridization, I have produced some ten hardy varieties of outdoor grapes, including many varieties that produce a regular annual yield, ripen on time and require absolutely no winter protection. Yet in the Crimea and the Caucasus all grapevines are buried in the ground for the winter for fear they may perish from frost. A remarkable example of the hardiness of my varieties of grape was provided in the winter of 1929 when the frosts in Kozlov (Central Black-Earth Region) reached 32°R. A twenty-year-old Antonovka apple tree, one of the hardiest varieties, perished from frost, but an unprotected grapevine survived; it was entwined about a nearby pear tree to the very top (a height of about five metres). In the following summer the vine bore its usual abundant harvest.

Thanks to breeding, all my grape varieties are not only completely indifferent to such injurious atmospheric conditions as frost, but are able to stand up to such abnormal environmental conditions as chlorosis, sunburns and blossom fall. But above all, *they do not fall prey to the numerous parasites, especially to phylloxera, that scourge of the grapevine.* These diseases and pests are inevitable in the home of the grape (France, Spain and the Crimea) and cause devastating damage to the vineyards. In France, for

example, the loss to vineyards in the sixties of the last century is estimated at 10,000 million francs. In our grape-growing regions, too, several tens of thousands of hectares have been destroyed by *phylloxera*. Between 1913 and 1927 over ten thousand hectares perished in Kakhetia alone.

What is the conclusion to be drawn from this? Plant breeding has enabled me to extend the northern boundary of grape cultivation, to use my own term, to Moscow, or as journalists are pleased to say, "to bring the South to the North," where pests like the *phylloxera* cannot become native.

I achieved the same result with cigarette tobacco. The development of tobacco cultivation in the Crimea, where it is practically the dominating factor of the economy, is hampered by the broom rape.

In my efforts to obtain a hardy and fragrant variety of cigarette tobacco suitable for cultivation in the central belt, I crossed Sumatra small-leafed tobacco with the early Bulgarian variety and developed my own local cigarette tobacco which is in no way inferior to many cultivated varieties. But in this case, too, plant breeding produced a number of highly useful properties in the hybrid variety. My tobacco proved so unexacting as to soil that it grows on barren sands, on meagre river deposits, and ripens in the climatic conditions of the central belt and even in the Ivanovo-Voznesensk Region and in the Urals (Verkhne-Kamensky Zavod). It is aromatic and burns without any admixture (benzoin, tincture, melilot, hops and other trash) which undermines the smoker's organism.

Or take the gooseberry. In view of the present state of affairs with regard to gooseberry cultivation, described above, I attempted to develop an immune variety by crossing one of the English varieties, the Duckswing, with the variety *Succirubrum* and as a result obtained a gooseberry which is quite immune to *Sphaerotheca*, and, in addition, is a bearer of large black berries.

Plant breeding enabled me to obtain also hardy and immune varieties of apricot. In the North Caucasus and in Uman and Mleyevo (Ukraine), the young shoots are wrapped in straw for the winter. In the Michurin nursery such protection is not practised.

But plant breeding sometimes produces really remarkable properties in hybrids. For example, I crossed the hybrid variety of Ideal sour cherry (interspecific hybridization) with the pure Japanese bird cherry *Prunus Padus Maackii* and produced a new plant which I named *Cerapadus*. In the first generation this variety bears fruit with such a high content of prussic acid and dyestuffs that it acquires great importance for the pharmaceutical and textile industries.

An even more amazing property of the *Cerapadus* is that it bears perfectly sweet berries already in the second generation. The leaves of the plants of both generations are harmful for pests.

The foregoing provides sufficient substantiation for the conclusion that *plant breeding is an important lever in increasing the yield of fields and protecting agricultural plants from diseases and pests*. But plant breeding will become a powerful practical factor in socialist construction only when

mastered by the masses. This impels me to draw the attention of the wide circles of the Soviet public to the necessity for:

1) introducing a course in practical plant breeding and mass experimentation in all the schools for young collective farmers and workers on state farms, in which my achievements and my methods should be liberally drawn upon;

2) organizing the procurement of new plants for cultivation. Members of the Komsomol, kolkhoz youth and members of young naturalists' clubs, school children and Young Pioneers should be enlisted for this work;

3) developing interspecific hybridization, by making wide use of wild fruit and small-fruit flora, for breeding high-yield and early-ripening varieties;

4) reproducing on a large scale those of my varieties which possess high qualities and are resistant to adverse atmospheric influences, diseases and pests.

This is the path which should be followed in our work to increase yields and protect our socialist crops. This path is as inevitable as it is necessary. By making a bold turn to this path, we shall score great achievements.

First published in 1931 in
Na Zashchitu Sotsialisticheskovo Urozhaya, No. 12

TO HORTICULTURISTS, SHOCK WORKERS AND RATIONALIZERS, TO THE KOMSOMOL AND KOLKHOZ YOUTH

Comrades, never and nowhere throughout the history of horticulture has the breeding of fruit and berry plants been conducted so correctly and on so extensive a scale as in the U.S.S.R. at the present time.

The Bolshevik Party and the Soviet Government have not only charted the course to be followed by plant breeding, but have assured its far-reaching development by opening wide to workers and peasants the doors of educational establishments, giving them free access to science, providing every opportunity for obtaining seed from remote areas of the U.S.S.R. as well as from abroad and for exchanging seeds. With unlimited scope and vast potentialities for their work, plant breeders should now strive persistently to produce high-yield, early-ripening and weather-hardy fruit and berry plants of outstanding qualities.

The choice of varieties is decisive for the success of the entire undertaking. But this cardinal problem will be solved only when plant breeding assumes a mass character, when plant breeding is introduced in the kolkhozes and sovkhozes on a wide scale. The sum and substance of the tasks confronting plant breeding today is to bring its ideas and practical methods from the studies of scientists and experimental stations directly to the orchards, to make them available to the masses of the kolkhoz peasantry, to Komsomol members and young shock workers seeking for new, rationalized methods.

We must reject, and with all the firmness we are capable of, the conservative views of the old-school superficial "experimenters" who maintain that at first varieties must be bred under artificial conditions, then "tested" by armchair methods, and only after that introduced in production. Obviously, work at such a pace cannot be tolerated in socialist agriculture. These conservative views on plant breeding have nothing in common with my work. The propagation of new varieties of plants from seed of artificial or natural pollination, and the application of a number of my other methods, as well as the testing of these plants should be conducted directly in the orchards, in kolkhoz and sovkhoz fields. The work should be organized as a single cycle. It should extend both to fruit orchards as well as to the mixed orchard and forest belts and groves which are now being planted over millions of hectares to combat drought and increase yields.

Science becomes a force when it is assimilated by the masses—V. I. Lenin taught us. And in plant breeding we must work as Lenin taught us. To do this, the following is necessary:

1. To make the most effective use of the experience and achievements of world plant breeding and of my methods for producing new varieties of plants.

2. To organize in sovkhozes and kolkhozes circles and clubs of plant breeders. Collective farmers, Komsomol members and youngsters should be enlisted to study the achievements of world plant breeding and my methods.

3. To introduce a maximum number of new plants for cultivation in our orchards and gardens. For this purpose close contact should be established with places where these plants grow, and the regular exchange of seed arranged.

4. To organize brigades to procure new plants in forests, mountains, steppes and marshes. All the best specimens should be planted in sovkhoz and kolkhoz fields.

5. The work of laying out orchard and forest belts and groves should be expedited, and plant breeding should be organized in them.

6. To institute prizes to be awarded on the principle: "a prize for the best variety, successful experimentation, for a newly-found useful plant."

7. To organize effective and regular contact between local circles of Michurin followers and the central circle, so that every experiment and achievement in plant breeding might be brought to the knowledge of the All-Union Scientific Research Institute of Fruit and Berry Cultivation and given the requisite guidance, direction and material support.

8. To organize effective and timely consultation on problems of plant breeding. This work should be entrusted to the central circle for the study of my methods and achievements at the Michurin Experimental Combine.

To the shock workers striving to find more rational methods I extend my ardent wishes for success in practical plant breeding.

I. V. Michurin,
Director of the Plant-Breeding and Genetics Station

First published in 1932 in *Kommuna*

MY ACHIEVEMENTS—A CONTRIBUTION TO CLASSLESS SOCIALIST SOCIETY

On the occasion of the fifteenth anniversary of the October Revolution, when the working people, led by the Bolshevik Party, are summing up the results of their victories in the great work of building Socialism, all scientists engaged in honest labour on the side of the proletariat take particular pleasure in summing up their own achievements for the past fifteen years.

Having devoted fifty-eight years to scientific research, forty-three years of them prior to the Revolution when I worked in a state of complete isolation, constantly aware that I was an outcast, a pariah whom none recognized, I now want to tell the working people not only about what they have gained from my scores of years of labour, but also about what I myself have gained from the Great Proletarian Revolution.

The aim of my life has been to improve the strains of plants, just as, on the initiative and instructions of the Party and the Government, constant improvements are being made in the instruments and means of production. The purpose of all these improvements is to satisfy more fully the requirements of the working people.

I worked hard to fulfil the aim I had set, though I was without means, had no established standing, was completely isolated from society, and was engaged in a constant struggle against poverty and stagnation, making the best of the meagre resources which, along with painstaking and at that time absolutely unpaid scientific work, I was able to earn by my personal labour as a railway clerk and precision mechanic. I carried through tens of thousands of experiments, always with my *one aim in view*. I performed a great deal of heavy physical work, suffered many hardships, and often severe privation.

Then came the October days of 1917, by which time I had collected eight hundred plant species from all corners of the globe and had bred several hundred new varieties of fruit and small-fruit plants, suitable for cultivation in the central, and in part, the northern regions of the country.

In those days I had a tiny plot of land planted with hybrids, which, however, were not made use of, for the disgraceful reason that under the tsarist-landlord system innovations were disregarded and ignored.

Now I am the director of a huge scientific research institution—the only one in the world as regards the work it does. Covering an area of several hundred hectares, it possesses many hundreds of thousands of hybrids, laboratories equipped with the most up-to-date scientific appliances, and employs a large and highly-qualified staff.

What is more, on the basis of my achievements there have been established: a fruit and berry combine comprising state farms covering a total area of five thousand hectares, a scientific research institute serving fourteen zonal stations and over one hundred local centres in the northern zone of the U.S.S.R., the first institute and technical college in the world concerned with

the breeding of fruit and berry plants, a workers' school and a number of other institutions which help to fulfil the decisions of the Party and the Government regarding the socialist reconstruction of fruit and berry cultivation.

We owe all this gigantic development of the work I began fifty-eight years ago to the exceptionally considerate attention and concern displayed throughout the entire period following the Revolution by the Party and the Government towards myself and the institutions under my direction.

The Bolshevik Party and the Soviet state have done everything to ensure that the work I had begun might prosper. This opened up vast opportunities for immediate large-scale, indeed mass, experimentation, and I ensured the production of a still greater number of hybrids.

At the present time the breeding station that bears my name does not require any material from abroad, whether cultivated or wild plants.

This I consider to be an outstanding achievement of the station entrusted to me.

The station now possesses its own Reinettes, Calvilles, winter pears, apricots, Reine Claudes, large-fruited cherries, sweet chestnuts and nuts, large-fruited raspberries and blackberries, black gooseberries, superior varieties of currants, early-ripening varieties of melon, attar roses, hardy grape varieties, cigarette tobacco, new Actinidia berries, and almonds. We are beginning the cultivation of rubber plants, Chufa, soya and peaches; numerous plants are being tested.

At the present time, my assistants and I are engaged on solving the following problems:

1) The production of so-called precocious, early-bearing varieties of fruit and berry plants.

2) The production of drought-hardy varieties of fruit and berry plants.

3) The organization of selection on a mass scale, which, in my opinion, will have to be carried through directly in the sovkhozes and kolkhozes.

4) The utilization of the wild fruit and berry plants of the Ussuri and Amur taiga, the Altai, Pamir and Caucasian mountains.

In devoting all my energy and all my experience to improving plant strains, I profoundly believe that the ever-increasing group of my followers, the group of plant-breeding experts that has grown, and continues to grow, in the combine that bears my name, will, under the guidance of the combine's Party organization, create a socialist fruit-growing industry, which, armed with advanced agricultural technique, will produce abundant yields and will be worthy of the classless socialist society.

On the occasion of the fifteenth anniversary of the October Revolution, I heartily congratulate all the fighters and builders of Socialism, the members of the Government and the members of the Communist Party.

First published in 1932 in
Nasha Pravda, November 6

TO COMMUNIST CHILDREN

Ever since V. I. Lenin took note of my work and the Soviet Government made possible the vast development of the work of improving fruit and berry cultivation, to which I have devoted fifty-seven years of my life, I have always been surrounded by workers, kolkhozniks, students, pupils of agricultural schools, Young Pioneers and school children.

My nursery is constantly being visited by healthy, cheerful children with a bent for creative endeavour. They come to learn how that old man Michurin strives not only to explain, but also to remake the nature of plants so that they might more fully suit the requirements of our working people.

And from what I observe in the talk of the children, their inquisitive questions, their interest in my work, in their understanding of problems of social and political life, I must say that under the capitalist system I did not find in children that amazing development, that natural unrestraint in their behaviour, that knowledge and proper understanding of the subjects that interest them, subjects which in the past would be beyond their ken.

Typical of our present-day Soviet children is Labynin, a pupil of the Michurinsk children's agricultural station that bears my name. For half an hour he delivered a speech before an audience of one and a half thousand adults and amazed them by the clarity of his understanding and explanation of the significance of introducing polytechnical education in the schools and of the socialist reconstruction of horticulture. Three girls, fourth-grade pupils in Kazan (75 Tutayevskaya Street), Ira Prudenko, Ira Vasilyeva and Dillyara Akhmajanova, read about my work in a magazine and wrote to me about reorganizing fruit growing in Kazan, something which has never been suggested to me by any adult in that city. Children in the village of Argamakov in the Middle Volga region, of the village of Dareyevichi, Starodub District, Western Region, children in many localities of the Chuvash Autonomous Region, the Northern Caucasus, the Ukrainian Republic, and distant Siberia organize circles to study the achievements of the Michurin nursery, lay out experimental orchards and gardens, enter into correspondence with me and at times travel hundreds and even thousands of kilometres to visit me.

And all this is done to accelerate the pace of the socialist reconstruction of horticulture. And how many striking examples do we have of creative effort by young people in factories, mills, sovkhozes, kolkhozes and in schools!

When talking to children I frequently think that throughout the history of human culture this is the first time that children have the opportunity to apply their abilities and energy for the good of society.

This is true only because the socialist system which was brought into being by the proletarian revolution has completely freed the mind of the child from the rubbish that was instilled in it by capitalism. Our children do not know the oppression and helplessness, the moral backwardness which are inherent in children of capitalist society with its ruthless exploitation, religious prejudices and poverty of the majority of the population. Capitalism, by giving all the good things in life to an insignificant section of society and cast-

ing into the vale of poverty and despair the majority of the people, cripples human nature. The existence of capitalism is unjust and criminal.

I greatly rejoice in the fact that Young Pioneer organizations have been in existence in the world for a decade, and I am certain that the world communist youth movement, under the leadership of the Young Communist International and the Communist International, will at last free mankind from the accursed tyranny of capitalism, just as this was accomplished by the working class of Russia.

The tenth jubilee of Young Pioneer organizations will serve to lay still firmer foundations for the communist youth movement and will stimulate the creative initiative of the children of the working people.

As for the field I work in, my wish for the next decade is that children—Young Pioneers and school children, little proletarians and collective farmers—develop fruit growing constantly and in every way. In my opinion, the following things have to be accomplished within the limits of a child's ability:

Firstly, under the guidance of teachers and Pioneer leaders to set up in schools and, still better, in sovkhozes and kolkhozes experimental orchards and gardens, and to raise there wildings of apples, pears, plums and cherries, to graft onto them the best cultivated varieties, to select plants for their hardihood and better quality of fruit and berries, constantly to select the seed of the best vegetables and melon crops.

Secondly, to study the problems of plant breeding, organizing circles for this purpose in the schools and in sovkhozes and kolkhozes. Special attention should be devoted to the study of cultivation methods; proper use must be made of machines and implements; to introduce fertilizers and cultivate the soil, properly to plant, trim, prune, graft and water the plants, pick the crop, combat pests, etc.

Thirdly, constantly to gather seed, carefully prepare them for planting, arrange for their proper storage. Children can do a great deal in this respect. If every sovkhoz and kolkhoz school would have its own seed-growing plot, if school children and Young Pioneers on eating an apple, pear, plum, cherry, cucumber, watermelon or honeydew melon would not throw away the seeds, but bring them to school, this would be of considerable help to seed growing, would accelerate the development of plant breeding which must play a prominent part in our polytechnilized school.

Fourthly, we must organize the search of new varieties for cultivation. There are very many plants on the earth, several hundred thousand species. However, man makes but little use of them. We need plants for industry, food, for our socialist towns, for medicinal purposes.

The Soviet Government devotes much attention to the work of procuring new plants for cultivation; substantial sums have been allotted for this work, and we have already many new industrial, fruit and berry and medicinal plants which relieve our country from the need to import them from abroad.

Our forests, mountains, steppes and marshes contain truly inexhaustible vegetation resources. We have to make use of this wealth for cultivation. School children of the Far East, the primeval forests of the Altais, Ferghana,

The Pamirs, the Caucasus, Crimea, the Urals, Kola Peninsula, Kirghizia, the steppes of the Ukraine and of Byelorussia must constantly search, in the small expeditions organized under the guidance of Komsomol members and teachers, for new fruit, berry, cereal, vegetable, industrial and medicinal plants.

Socialist emulation must play an important part in this; prizes should be offered for every newly-found plant.

By doing all this, we will, under the conditions of our socialist system, all the sooner accomplish the task of regenerating the land, a task bequeathed to us by that great teacher and friend of all the oppressed—Vladimir Ilyich Lenin.

I shall try, by my work, to help the growing generation of Socialism better to understand the vast importance of improving plants. I shall pass on my knowledge, experience to communist children with the greatest pleasure.

I ardently wish the communist youth movement in the next decade to cope still more successfully with its class tasks and to attain in practice the fulfilment of Lenin's behests.

June 30, 1932

First published in 1932 in
Pionerskaya Pravda, July 15

DROUGHT CONTROL IN FRUIT GROWING

For drought control and higher yields in fruit orchards, just as in grain growing, we must first of all pay maximum attention to the proper selection of drought-resistant varieties. And the breeding and selection of drought-resistant material must be carried on with a view both to the varieties of fruits and small fruits and, particularly, to the stocks for them.

But in selecting such varieties for culture, it is necessary always to pay attention to the nature of their root system. For example, while favouring the more frost-hardy type of Siberian apple for fruit growing, we nevertheless cannot recommend it as a stock in droughty regions, because its root system is more horizontal, usually situated in the upper layers of the soil, with only a few roots extending farther in depth.

For the production of drought-resistant varieties, stocks from the universally-known orchard Kitaika [*Pyrus prunifolia*] are more suitable, as it develops its root system in a vertical direction, penetrating the deeper layers of the soil.

However, even in the case of the Kitaika it is necessary to be circumspect in the choice of seeds and give preference only to those of its trees which have grown up not in a moist, lowland soil, but in more elevated dry places removed from the subsoil water. Seeds from trees growing in a low-lying moist soil will produce less drought-resistant plants and, vice versa, seeds from trees growing in a dry place will produce more drought-resistant plants.

Our wild apple, which grows in local forests not situated in low-lying marshy places, fully meets the task of obtaining drought-resistant seedlings to serve as stocks.

As a second choice, seedlings of the wild apple from the uplands of Northern Caucasus may be used.

That is all that concerns stocks for apples.

As regards stocks for pears, our choice is much smaller, because there are few wild-growing pears in the forests of the northern and central regions of the R.S.F.S.R. and, consequently, we cannot obtain a sufficient quantity of their seeds. As for the southwestern forest pears, which grow abundantly in the forests of the former Kursk, Voronezh, Kharkov and Kiev provinces and in general throughout the Ukraine and Northern Caucasus, they cannot be ranked among the foremost as regards hardiness of the roots to our winter frosts, as, for example, the wild Ussurian pear and its varieties from the slopes of the hills in the Blagoveshchensk area, Eastern Siberia, which is suitable for us in every respect. Lately also a species of birch-leafed pear from the Tian Shan Mountains in the Tashkent area has been proved to be highly drought- and frost-resistant. The majority of pears from the mountainous areas of the Caucasus should be regarded as a second choice in respect of hardiness to drought and to winter frosts.

Besides planting trees which grow tall, we must also cultivate their dwarf forms on a large scale. Our Lower Volga Paradise may to some extent serve as a stock for apples, but it should only be regarded as a second choice in respect to drought resistance and, perhaps, also in respect to frost-hardiness.

For the time being I consider a Paradise hybrid I have produced by crossing a broad-leafed English Paradise with a choice variety of dwarf Kitaika (so far not yet propagated by layers) as more fully meeting the requirements of a dwarfing stock.

Fairly satisfactory results in the choice of stocks for dwarf forms have also been obtained from experiments in the grafting of apples on the service tree. The results are satisfactory both as regards the dwarf growth of the apple varieties grafted on it and as regards their frost-hardiness.

For the cultivation of trained dwarf pears I have bred the Severnaya (Northern) quince, a cross between the wild Caucasian quince and varieties of the Sarepta quince from the Volga area. It is frost-hardy and requires relatively less moisture than all former species of quince. Experiments have also shown that the service tree is quite suitable as a stock for pears too.

A specially stable kind of blackthorn, which I have bred, may serve as stock for plums, when it is required to induce drought resistance and dwarf growth. It produces no root shoots, which is a very valuable characteristic.

Of cherries I can unhesitatingly recommend for these purposes the dwarf variety Michurin Plodorodnaya, which I have bred. It is of a high standard, without equal among other kinds of cherries both in respect to frost-hardiness and in respect to abundant annual crop yields.

This cherry is almost the sole self-fertile kind, and its seedlings are the best dwarfing stocks for training culture. Besides, we may always find among Plodorodnaya seedlings a large percentage of constant specimens, i. e., strains which are in their turn suitable for culture, particularly for the in-

troduction of cherry culture to new regions, more to the north, in the Urals and in the Far East.

Another powerful means of drought control for the future will be to select among hybrids and to breed new drought-resistant varieties of fruits and small fruits by rearing them in elevated places situated above the soil waters, preferably in light sandy loam and, as far as possible, without the application of artificial watering.

Those are the points which I consider to be the most important for drought control in the fruit orchards of our strictly continental areas of the Black-Earth Belt. As for future shelter plantations for fields, which will make up meliorative orchard strips and groves for the retention of snow with the aim of saving moisture, it is a question which requires more detailed examination in a special article.

First published in 1934 in *Proceedings of the I. V. Michurin Plant-Breeding and Genetics Station*, Vol. II

ENRICH NATURE. MY WISHES TO THE KOMSOMOL

An extensive movement of amateur horticulturists has long since developed around my work; it has attracted the kolkhoz youth as well. However, this movement has as yet not produced the results the country expected. Why? One must say outright, young comrades, that so far this movement is confined mainly to oral, and in some cases, written propaganda of my work and methods of breeding new varieties. But the most important thing is *to apply these methods in practice in the sovkhozes and kolkhozes.*

Collective farms, state farms, educational establishments and even hospitals apply to me for plants or seeds of my varieties. These requests total up to many hundreds of thousands of plants annually, and in the last two-three years, to millions. What is characteristic, however, *is that I hardly ever received requests for planting material and never conducted any correspondence with those who, so to speak, due to their official position, should handle such matters—regional and district land departments, fruit-tree nurseries, forest nurseries, reclamation stations, etc.*

But our Central Genetics Laboratory is engaged not in simple commercial propagation and sale of plants, but exclusively in breeding new varieties. It is high time this was understood.

Today a tremendous interest in horticulture, the planting of trees in towns and the regeneration of the land is growing among the masses of workers and collective farmers. Comrade Stalin has now set us the task of planting shelter belts of fruit and other trees to combat drought.

How can you, members of the Komsomol, help in this? You can do a great deal. You are young, strong and keen. You must see to it that not tens, but thousands, millions of apple, pear, plum trees, grapevines and raspberry shrubs of new varieties bear fruit in our kolkhoz and sovkhoz orchards.

The *first* thing to do is to organize Komsomol brigades of young enthusiasts with a flair for horticulture *to collect seeds of wild-grown fruit and berry plants in forests, mountains and valleys.*

The *second* thing which you, young friends, can help to develop. Beginning with the spring of 1935, it is necessary *to lay out large-scale fruit and berry nurseries* throughout the country, in all districts where fruit growing is possible.

The *third* thing. I would ask the "light cavalry" of the Komsomol *to check up what is being done by zonal stations and Michurin institutes for the study and the distribution of new varieties.* There are instances of my varieties being replaced by old ones. There are cases of new varieties being condemned wholesale as non-hardy, whereas in reality they simply perished from frost due to outrageously poor care.

The *fourth* thing. "Michurin circles" have sprung up throughout the country, and there is an extensive movement on foot to organize village laboratories. What is required is to check up on how these circles are guided and see that they work correctly.

The *fifth* thing in which you can help a great deal. New plants have to be sought for. My experience of sixty years in utilizing East-Asiatic wild-fruit and berry flora for hybridization has convinced me that those parts of the country still have a large number of entirely unknown, or known but unused, plants suitable for breeding and cultivation purposes. The plants of the Far East enabled me to produce by crossbreeding an extremely rich assortment for the central and partly for the northern zones of the country. This prompted me time and again to outfit expeditions to the Ussuri-Amur taiga, the banks of the Bira, Bijan and the Zeya rivers, the vicinity of Blagoveshchensk and the Transbaikal area. The youth must tackle this work. Do you know that this year a small expedition of Young Pioneers to the Altai Mountains resulted in a tremendous victory? Within two months the children were able to find in a 500-kilometre zone 13 varieties of onions, 20 of gooseberries, 27 of red currants, 20 of black currants, 9 of raspberries, 2 varieties of perfectly sweet bird cherry, blackberry, Mokhovka and many highly interesting decorative plants. This was accomplished by a small group of children.

Think, what could be accomplished if you, the Komsomol, make this one of your regular tasks!

The *sixth* thing, comrades. Our socialist cities must be beautiful. Our country possesses immense vegetation resources for decorative purposes. But cast a glance around you. Accidental, dwarfish, slow-growing plants, often ugly in appearance, are used, though there are valuable and beautiful varieties in dense forests of remote areas.

The rolling steppes of our Southeast possess a worldwide diversity of tulips, lilies, amazingly beautiful orchids, roses, hyacinths, gladioli.

And what about the lonciera, the jasmin, the Amur cork tree, or the ailanthus! Or the most beautiful and hardiest plant of the Altai, the red-flowered *Rhododendron dahuricum* which blooms in the snow.... Many such examples

could be cited. *All these plants must adorn workers' centres, and not remain only in the taiga.*

Our country must in outward appearance too be the finest in the world!

But this is not all you can do, comrades of the Komsomol. You must *master the technique of fruit growing and decorative gardening*. This is the *seventh* thing, and it is highly important. You must master the technique of collecting seeds and preparing them for planting, you must learn grafting and pruning, how to handle pest-fighting equipment. And in this work you must not ignore *the experience of the old gardenists.*

The members of the Komsomol are making it their job to develop fruit growing, they must learn how to handle the grafting knife!

A few more remarks. We must not lose sight of the fact that our country represents a combination of the most diverse geographic and climatic conditions. Hence Komsomol members in each region should have their own specific tasks in the development of horticulture.

While Komsomol members in the Donbas and the Ukraine can and should select for new orchards the splendid assortment of fruit plants which has existed for centuries in their localities, Komsomol members of Khibinogorsk, Magnitogorsk, Solikamsk or Archangel face a somewhat different task. They must utilize the local wild-growing berry shrubs, transfer them from the forest to experimental large-scale plantations and breed *new varieties* of fruit and berry plants by drawing on the experience of world plant breeding and by applying my methods.

The task of Komsomol members in *Siberia and the Far East* is to cross local wild-grown varieties of apples and pears with varieties from the European part of the Soviet Union.

In their work of developing horticulture the Siberian Komsomol members can advance along a charted path.

On this sixtieth anniversary of my work there is no higher and better reward for me than the certainty that you will fulfil the wishes I expressed in this letter.

Michurinsk, September 16, 1934

First published in 1934 in
Komsomolskaya Pravda, September 20

THE DREAM OF MY LIFE

Sixty years ago when I was a youth of twenty, I made up my mind to renew the old assortment of the semicultivated low-yielding varieties of fruit plants that existed in the central part of European Russia of those days. Such an idea might have been formed under the influence of a certain innate inclination of mine or, perhaps, it was due to the fact that all my childhood passed in the particular surrounding of plant breeders.

At first I groped in the dark, but as time passed and my experience increased the conceived plan gradually crystallized into the following definitely outlined program:

1. To originate a variety of fruit plant of the highest economic value.

2. To lay the foundation for fruit growing in the North, i.e., to extend farther north—as near to the Arctic circle as possible—the region where the apple, the pear, the plum and the cherry can be grown; at the same time to introduce into the central, and partially into the northern zone, such southern cultures as grape, apricot and peach.

3. To transform into highly-cultivated fruit plants with edible fruit such cold-resistant, high-yielding wild forms bearing fruit every year as the mountain ash, the hawthorn and the bird cherry.

4. To create entirely new species of plants that could satisfy more fully our demands.

These ideas and desires have been my lodestar all through the sixty years of my way towards the goal of my life. Mine had been a thorny track through the gloom of the tsarist regime, under which passed sixty-three years of my life and forty-three years of my work.

To achieve my desire it was necessary to change the firmly established order of life in plants and to set up a new order—such as would suit man's needs.

This has taken many years—and what years they were! Before the Revolution my whole path was strewn with derision, neglect and oblivion.

Before the Revolution I used to be insulted again and again by the judgments of ignoramuses, who declared all my work to be useless, to be mere "fancies" and "nonsense." The officials from the Department of Agriculture shouted at me: "You dare not do it!" The official scientists declared my hybrids to be "illegitimate." The clergy threatened me: "Don't commit blasphemy! Don't turn God's garden into a brothel!" (that is how hybridization was characterized).

But when the old system was overthrown by the workers and the peasants under the leadership of Lenin and his Bolshevik Party, I crowned my ideas and desires with actual achievements.

Socialist construction carried on under the guidance of the Bolshevik Party with Comrade Stalin, the dear leader of all working people, at the head, has already made all of us live to see the wonderful deeds achieved both in cities and in villages, in the laboratories of industrial plants and academies, deep in the entrails of the earth and high up in the air.

I have a feeling as if now, in the eightieth year of my life, I have suddenly met an agreeable person I had never known before. Everything has changed so wonderfully.

What can there be more wonderful for me than the fact that the sixtieth anniversary of my life's labour and my modest accomplishments are being celebrated as the festival of Soviet horticulture?

It is no wonder then that now I am working at such problems as the production of a frost-resistant peach, the possibility of originating new species of plants by applying various kinds of radiant energy—the cosmic rays, the Roentgen and the ultraviolet rays—as well as by ionization; that I am tackling the problems of producing precocious fruit-plant varieties beginning

to bear fruit at an early age, and of obtaining seedless grapes. I have at my disposal everything I need to think and work quietly and undisturbed.

I am happy to feel every moment the concern and care bestowed upon me by the Communist Party and the Soviet Government. But the fact of the greatest importance for me is that now my life dream has become a reality, public attention has been drawn to the necessity of improving the plant.

I have no other desire than to pursue side by side with thousands of enthusiasts the cause of the renovation of the Earth—the goal to which great Lenin had called us.

First published in 1934 in
Pravda, September 18

ANSWERS TO THE QUESTIONS OF THE EDITORIAL BOARD OF THE JOURNAL *FOR THE MARXIST-LENINIST NATURAL SCIENCE!*

Question One. My evaluation of the present state of science in the Western countries and in the U.S.S.R. is as follows:

The economic crisis that has spread all over the Western countries and has shaken the entire basis of capitalism could not but affect the field of the natural sciences as well.

If in the Western countries during the period preceding the crisis very little was done as concerns the production of new improved fruit-plant varieties, all the more now, under the conditions of the most severe crisis, no work whatever is to be expected in that direction.

Both in the foreign press and in our Soviet press, my work has been frequently compared with that of the American fruit grower Luther Burbank. I consider this comparison a wrong one. My methods of work are different from those of Burbank, as it was already pointed out long before the Revolution by those American professors who used to visit my nursery systematically every year. The same is also true as regards the organization of work of other private workers in this field in Western countries as well as of the state experiment stations, among which hardly any can be found that would work exclusively on originating new improved fruit-plant varieties.

On examining catalogues of horticultural plants either of the American or of the West-European fruit-trade firms it can be seen that over a period of several decades there were hardly ten new varieties accepted for sale. The question arises, where are those many thousands of new varieties claimed to have been originated both by Burbank and by all the other foreign fruit-plant breeders, about whose work so much and so frequently has been written in the foreign press and in our Soviet press as well? Apparently much of what has been described either existed only in the authors' imagination or proved to be unsuitable for practical purposes. This is only to be expected because the conditions of life under the capitalist system weigh upon the actions of workers in every field in the Western coun-

tries. Almost any activity in those conditions is confined to making profit; moreover, a small group belonging to the ruling class appropriates almost all the products of the labour of the working masses.

An entirely different state of affairs is to be found in the U.S.S.R. under the Soviet Government, after the beneficial abolition of classes. Here in the U.S.S.R. everything is based on the aspiration to increase by all means the prosperity of the working people.

Thus, in our country such great attention has been drawn to the development of fruit growing that in the nearest future vast territories of our Union will be occupied by wide uninterrupted stretches of orchards-fields each having a total area of several thousand hectares. This unprecedented impetus towards the development of fruit growing in the U.S.S.R. could be brought about only by the October Revolution that released the hitherto fettered productive potencies of the earth and gave the power to the proletariat—the most progressive class of the socialist society.

How magnificent and alluring are the prospects of development of scientific research in the U.S.S.R. can be illustrated sufficiently well by just one typical fact: before the Revolution I worked all alone without receiving a single kopek for the development of my enterprise from the autocratic tsarist government, while at present a number of institutions have been established on the basis of the results of my fifty-nine years' work. These are the plant-breeding and genetic research station named after me, a horticultural college, a research institute, a school for fruit growing and a state orchard farm of five thousand hectares.

Owing to the generous help of the Soviet Government the very pace at which my work progresses has changed so profoundly that during the single year of 1932 I succeeded in performing the same amount of work as during the whole of the preceding decade.

After the Second Five-Year Plan is fulfilled the tempo of work on improving fruit-plant varieties and on producing new varieties will be still further accelerated. In addition to all that, I should like to call attention to the fact that the unexpected occurrence of new elements in the chemical composition of the flesh of certain hybrid apples—elements that are normally never present in the flesh of the different pure apple species—makes it possible to presume that in the course of the future large-scale hybridization work, such varieties will be obtained the fruits of which will prove to be useful in curing certain human diseases.

Question Two. My views on the interrelations between natural science as a whole and my specific branch of it on the one hand and philosophy on the other hand are as follows.

Science, and its concrete branch—natural science—in particular, is inseverably bound up with philosophy; but since man's world outlook manifests itself in philosophy, the latter is, therefore, a weapon in the class struggle.

Partisanship in philosophy is the chief orientating factor. The structure of things determines the structure of ideas. The progressive class, as the proletariat has proved itself to be, is the vehicle of a more progressive ideolo-

gy; this class is creating a unified and consistent Marxist philosophy. By its very nature, natural science is materialistic, materialism and its roots lie in Nature. Natural science spontaneously gravitates towards dialectics. To understand the problems of natural science properly one must understand the only true philosophy—the philosophy of dialectical materialism.

Question Three. Only on the basis of the teachings of Marx, Engels, Lenin and Stalin can science be fully reconstructed. The objective world—Nature—is primary; man is part of Nature, but he must not merely outwardly contemplate this Nature, he can, as Karl Marx said, change it. The philosophy of dialectical materialism is an instrument for changing this objective world; it teaches how to actively influence Nature and how to change it; but only the proletariat is capable of consistently and actively influencing and changing Nature—this is what the teachings of Marx, Engels, Lenin and Stalin—those unexcelled titanic minds—tell us.

The practice of socialist construction in the U.S.S.R. has raised a series of new colossal tasks that only the proletariat is capable of fulfilling. The proletariat has proved this by its deeds. The Soviet scientists have to face the most urgent problems raised by the construction of industrial plants, state farms, collective farms on an enormous scale. These problems could be solved only in the land where Socialism is being built and only with the aid of the philosophy of dialectical materialism elaborated by Lenin on the basis of the principles of Marx and Engels.

Question Four. What is my opinion of the possibility of applying materialistic dialectics to horticultural science and in what ways can this be done?

I must say that I have spent all my life in the orchard and on the garden beds. During my life I have made a great many observations and studies of plant life. I have discovered hosts of new facts that still await their theoretical significance to be investigated by science. Those facts must certainly be thoroughly elucidated and investigated in detail from the theoretical standpoint. Here is where the help of materialistic dialectics as the only true philosophy of consistent materialism is needed.

Question Five. What are the principal theoretical problems as regards the improvement of the qualities of new fruit-plant varieties that require the most urgent investigation?

In my opinion the most urgent is the problem of accelerating the initiation of fruiting—making fruit trees begin to bear at an earlier age. Next comes the problem of creating new plant species more useful to man by means of interspecific hybridization. Then, I repeat again, a problem of major importance which should be tackled not by individual scientists, but by the united efforts of all scientists is the finding of ways and methods of introducing into the chemical composition of the fruit's flesh chemical elements hitherto unusual in the plant, but that are of great value to man.

First published in 1934 in
Proceedings of the Michurin Plant-Breeding and Genetics Station, Vol. II

TO THE TRANSCAUCASIAN TERRITORIAL COMMITTEE OF THE KOMSOMOL; TO KOMSOMOL ORGANIZATIONS IN AJARISTAN, ABKHAZIA AND OTHER SUBTROPICAL REGIONS

Dear comrades,

It is my good fortune to see frequent and convincing proof that the great idea of *V. I. Lenin* on the regeneration of the land is becoming a practical task for the millions of Soviet people.

But it is especially gratifying to me that this majestic idea has gripped the minds of the members of the Komsomol. Members of the Komsomol in the national republics of Transcaucasia, particularly of Ajaristan, Abkhazia, Ozurget, Poti, Azerbaijan—whose fathers, grandfathers and great-grandfathers throughout the history of these regions, right up to the October Revolution, lived in oppression and were never masters of their beautiful land—today, under the leadership of the Party, set examples of Bolshevik work in the development of Soviet subtropical agriculture. The more than a hundred kolkhoz nurseries that you have organized furnish splendid proof of this.

The Komsomol in Moscow Region and Western Siberia, the Far East, the Ukraine and the Donbas also has to its credit achievements in extending agriculture to the North, introducing new crops, doubling and trebling the yields of sovkhoz and kolkhoz fields, orchards and gardens.

For this reason, Komsomol members of Transcaucasia, I cannot but rejoice in your achievements and tell you my wishes.

First and foremost, comrades, I draw your attention to the need for overcoming the existing incorrect view regarding the subtropics, so that it should not influence practical work.

The teachings of Marxism on imperialism and the colonies (the colonies are located chiefly in the tropics and subtropics) show that only eighteen per cent of the globe's surface is used for agriculture, that the main area of unutilized lands is located in the tropics and subtropics, that in the future, when the workers of all countries unfurl the Red Flag over the entire globe, the tropics and subtropics will become the granary of all of working mankind.

That is why I, working all my life on advancing fruit and berry cultivation northward, never forget the subtropics, and first and foremost our Soviet subtropical areas.

Our subtropics cover a vast area and contain immense potentialities. The utilization of these potentialities will begin first of all with the breeding of all agricultural plants, both leading and secondary ones.

Now here are my wishes:

1. In order to create in the Soviet Union the *finest subtropical agriculture in the world* I propose thoroughly to search all the tropics and subtropics of the globe. The best that can be found of lemons, oranges, tangerines, tea,

Diospyros lotus, and other subtropical plants should be brought to Transcaucasia and, through plant breeding, advanced further north.

2. *To develop in every way experimentation on a mass scale* on the basis of scientific findings, with utmost encouragement to every positive result. The practical experience of older gardenists, frequently of great value, should in no way be ignored.

Promote the work of young experimenters in sovkhozes and kolkhozes, help them in their efforts through scientific and agricultural organizations, render them every possible assistance, boldly apply in practice the achievements of young experimenters.

3. *Intensive training of plant breeders.* The point is that in some places there is a serious flaw in the training of personnel. At present we train for fruit growing all-round agronomists, with stress being laid on cultivation methods. This is not exactly right. Without underestimating the tremendous importance of cultivation methods I must stress also the part played by plant breeding, especially in the Transcaucasian republics with their varying soil and climatic conditions and the role that subtropical agriculture has always played in their history.

4. It would be narrow-minded for the Komsomol to devote its efforts exclusively to the development of subtropical agriculture. *Everything must be done to develop fruit and berry growing in your subtropical areas.* By properly selecting the assortment and by utilizing the varieties and species abounding in the old Circassian orchards and groves, the cultivation of apples, pears, apricots, peaches, quince, cherries and plums in Abkhazia, Ajaristan and other districts can within the next five years become not only a food-supply factor, but also an important source of raw materials and exports. Scientific and mass practical plant breeding is in our hands, and in this sphere the Komsomol can play a tremendous part.

I am confident that the Komsomol of Transcaucasia, under the leadership of the Communist Party and the territorial committee of the Komsomol, will take up with utmost energy the task already started, the creation of a Soviet Florida and California on the coast of the Black and Caspian seas.

In conclusion, I want to express my profound gratitude to the Regional Territorial Committee of the Komsomol, as represented by its delegation, for its attention and kindness.

First published in 1935 in
Komsomolets Abkhazii,
No. 3, January 28

SUBJECT INDEX

INDEX OF LATIN NAMES OF VARIETIES